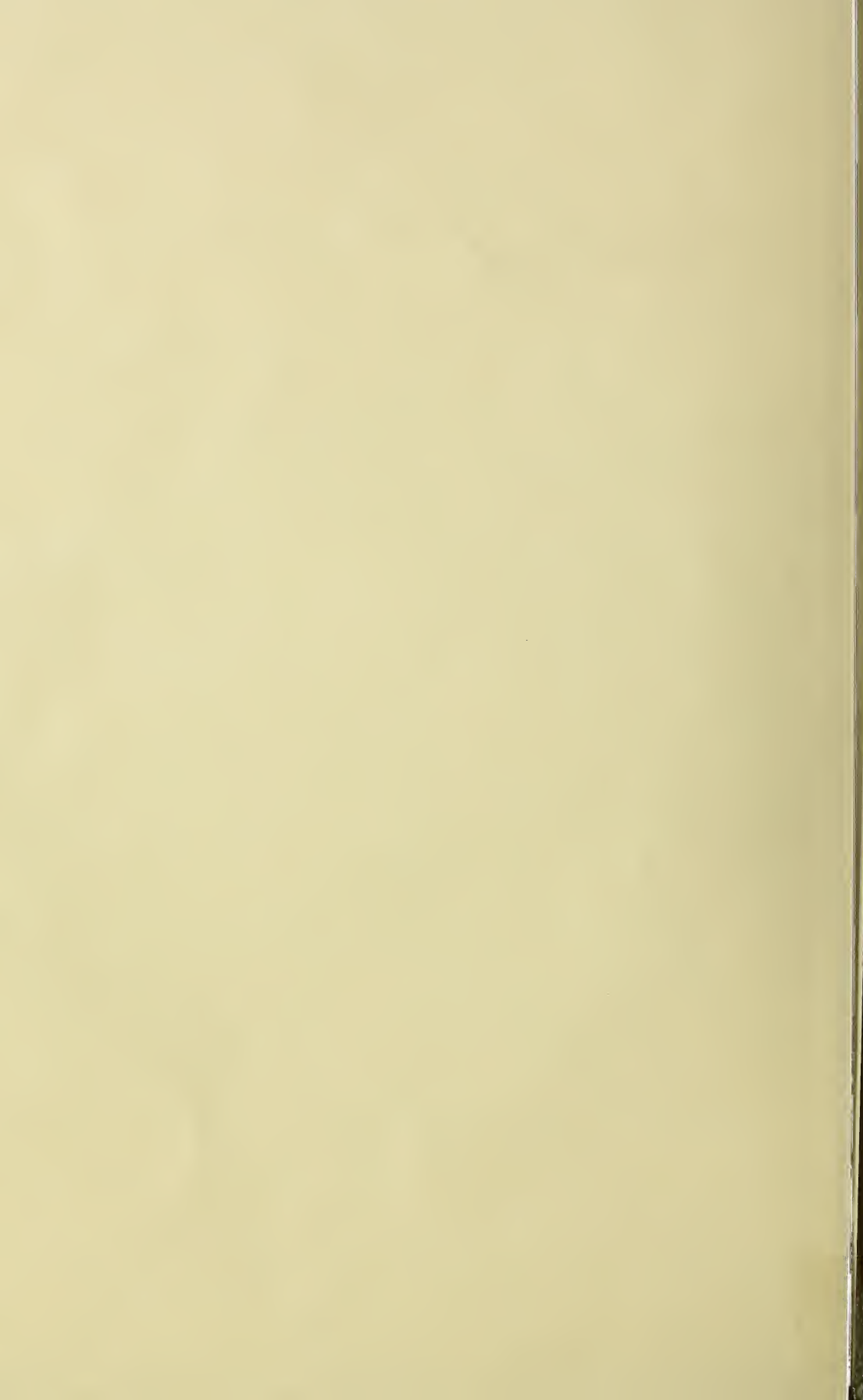


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VOLUME XXIII

NUMBER 5

THE AGRICULTURAL STUDENT

OHIO STATE UNIVERSITY, COLUMBUS, OHIO



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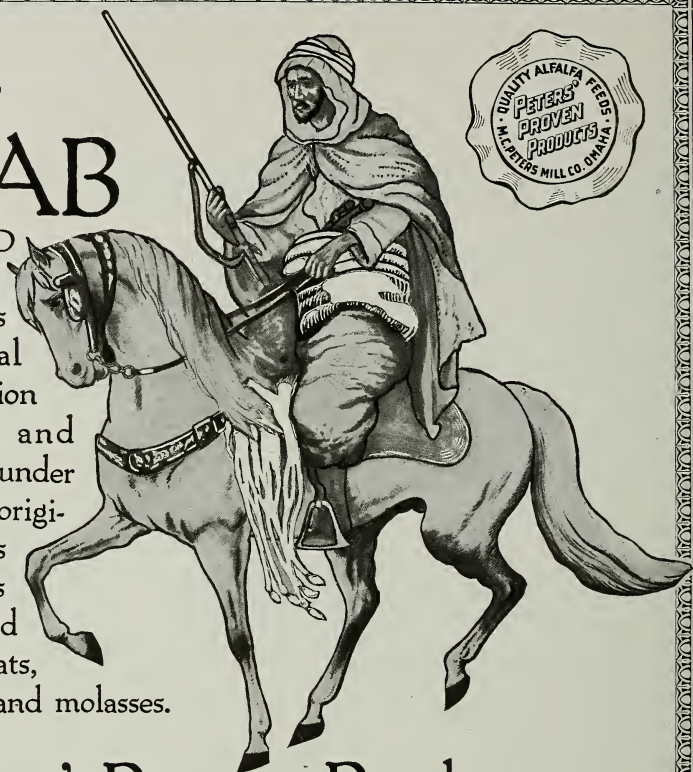
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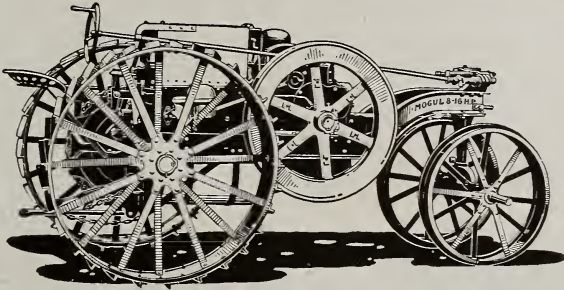
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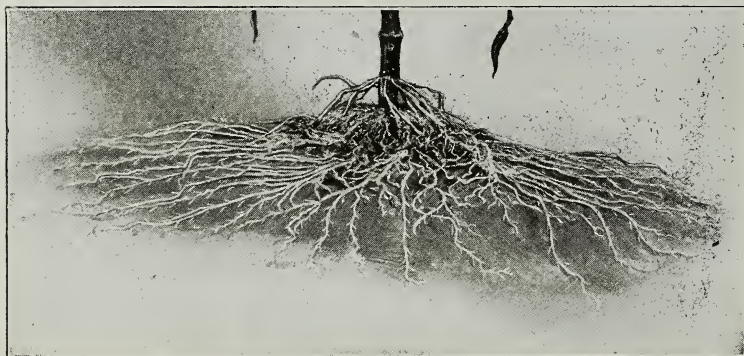
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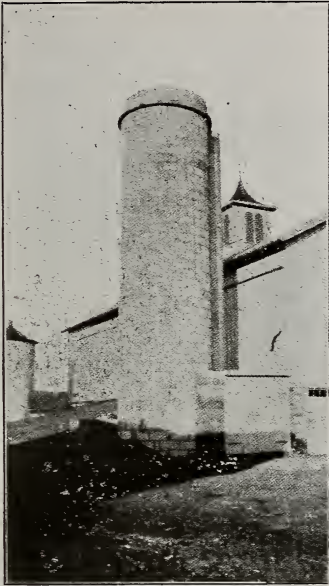
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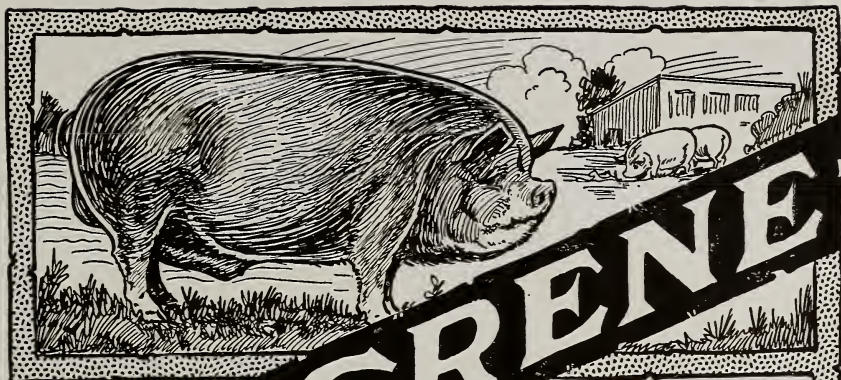
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January 29, 30, 31, February 1 and 2

Ohio State University

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An equally good program has been arranged this year. Come and hear **Herbert Quick, J. G. Lipman, W. H. Tomhave, Henry M. Dunlap, W. H. Card, E. C. Eikenberry, Ralph A. Felton, S. W. Fletcher, Julius Kahn, C. W. Waid, Moses Breeze, H. J. Sconce, H. C. Thompson, Rose Morgan, Virginia Meredith, Isabel Bevier, President W. O. Thompson, Dean Alfred Vivian, Director C. E. Thorne and many others.**

Meetings of the most important farm organizations in the state, including the Ohio State Dairymen's Association, Ohio State Horticultural Society, Ohio Vegetable Growers' Association, State Farmers' Institute, Ohio Rural Life Association and various breed associations.

The great Ohio State Corn Show, Dairy Show and Horticultural Exhibit will swing their doors open to all during Farmers' Week.

One hundred and fifty farm boys and girls, winners in county contests for raising the best pigs, poultry, keeping dairy records, and excelling in canning and baking, will receive free trips to Farmers' Week. Come and watch them compete in state-wide contests.

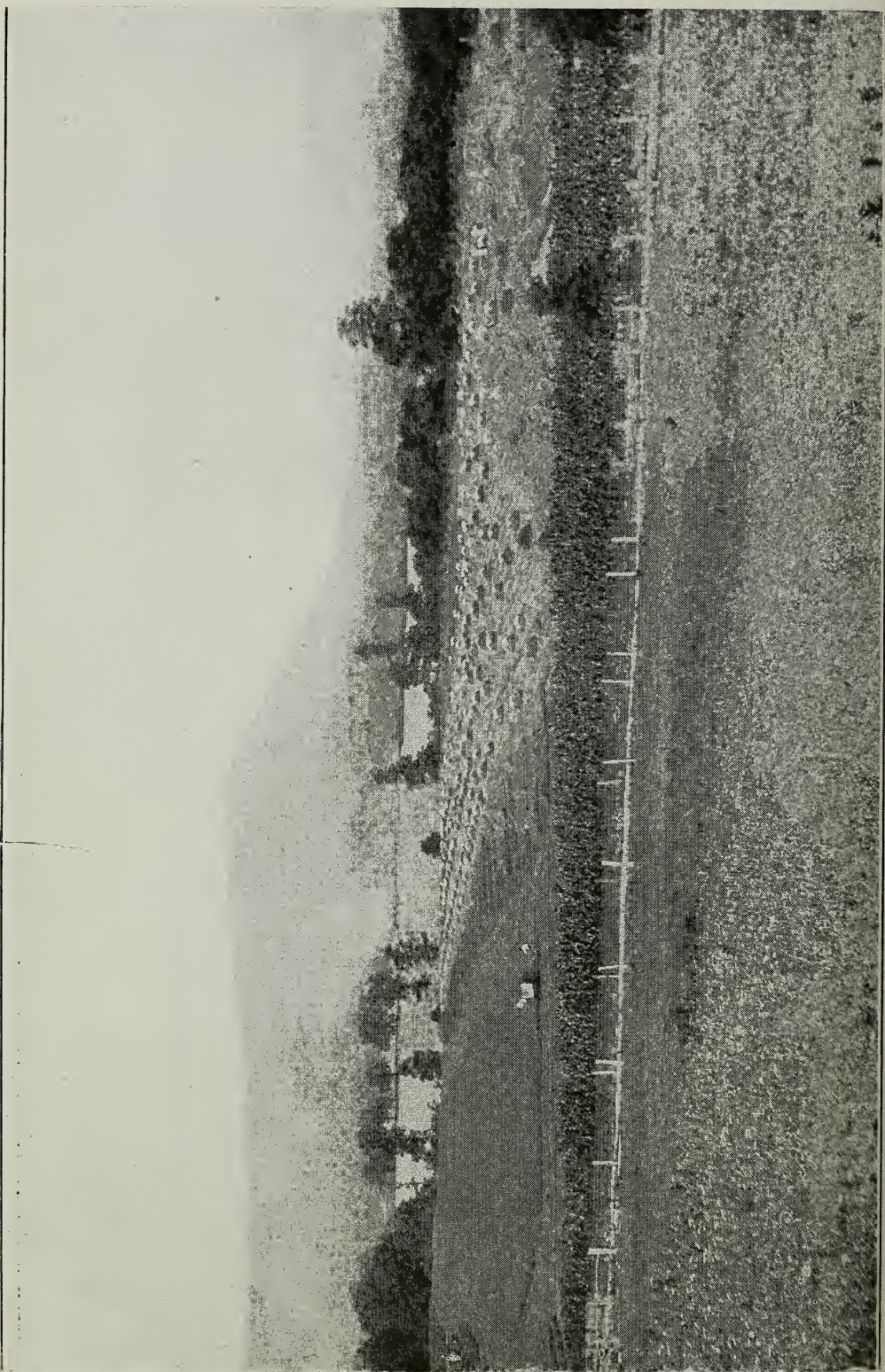
Bring your wife and daughter, too. The new Home Economics building will be turned over to the wives, daughters and sisters of Ohio farmers for one week.

THE ANNUAL ALUMNI LUNCHEON will be held in **OHIO UNION, WEDNESDAY, JANUARY 31.** This is the annual gathering during Farmers' Week of all graduates and all former students in the four-year, two-year and eight-weeks courses. You will meet some of your old friends. In former years this meeting of former agricultural men has developed into a very pleasant affair.



CONTENTS

	Page
FRONTISPIECE	278
INOCULATING THE SOIL FOR LEGUMES—	
Lewis T. Leonard	279 ✓
EFFECT OF FERTILIZERS ON NITROGEN IN SOILS—	
Robert M. Salter.....	282 ✓
NITROGEN FIXATION INDEPENDENTLY OF LEGUMES—	
Firman E. Bear.....	288 ✓
INCREASING THE NITROGEN IN SOILS WITH LEGUMES—	
George M. McClure.....	290 ✓
SHOULD WE GROW ALFALFA IN OHIO?—	
Wallace E. Hanger.....	293
POSSIBILITIES OF SWEET CLOVER ON THE FARM—	
Andrew S. Wing	295
THE PROBLEM OF SOIL ACIDITY—	
Sidney Bliss	297 ✓
SHOULD OATS OR SOY BEANS BE GROWN IN ROTATION?—	
Leonard Hill	300
GROWING RED CLOVER IN THE ROTATION—	
Jay B. Park.....	303
CONTROLLING HELPFUL AND HARMFUL INSECTS—	
L. O. Howard	306
EDITORIALS	308
HOME ECONOMICS	311
SECONDARY AGRICULTURE	313
ALUMNI NOTES	315
NEWS NOTES	317



THE AGRICULTURAL STUDENT

Vol. XXIII.

OHIO STATE UNIVERSITY, COLUMBUS, JANUARY, 1917

No. 5

INOCULATING THE SOIL FOR LEGUMES

How Bacteria Draw Unavailable Nitrogen From the Air, Make It Available and Place It at the Disposal of the Plant; Methods of Applying Inoculating Material to the Field

LEWIS T. LEONARD, United States Department of Agriculture

SOME species of nonleguminous plants and practically all known leguminous plants are capable of entering into a mutual relationship with an organism whose various types or strains are listed at present under the name *Bacillus radicicola*. The plant in this symbiotic relation apparently offers to the bacteria a place of refuge wherein they may develop their own kind in the absence of foreign organisms and draw on the plant for the carbohydrate and inorganic substances necessary for their nutrition. In return the bacteria draw unavailable nitrogen from the air, make it available and place it at the disposal of the plant.

Cultures of *Bacillus radicicola* can live almost indefinitely on artificial media under certain conditions without any relation to their specific legume plant host. Sometimes cultivation under such conditions will influence adversely the ability of the organisms to produce nodules. There is considerable evidence that these organisms can perpetuate themselves in field soil in the absence of the legume over long periods of time. It has been proven that they can fix atmospheric nitrogen independently in artificial media and sterile soil. This leads to the conclusion that the plant is not necessarily a factor in the life of the organism.

As the value of the legume plant in

farming depends to a great extent on its nitrogen content, it is necessary in the absence of nitrogen-fixing bacteria from the roots to have the element nitrogen in an available form supplied by some means. This can be accomplished by the addition of a soluble nitrogen salt such as sodium nitrate. It is easily seen that under natural conditions much of this salt would be carried away in drainage water. Undoubtedly legume plants can be grown successfully in the absence of legume bacteria and vice versa, but with such a wise provision for the natural secretion of atmospheric nitrogen thru bacteria and plants in mutual relationship, it is the only practical and economical scheme to follow.

The use of legume bacteria, as they are commonly called, needs no defense in the light of the experimental and practical demonstrations of their value. It is a necessity. The point to determine is the presence or absence in the soil of the specific strain of legume organisms necessary to produce nodules on the legume crop. This may be done to some extent by laboratory tests but the results are often inconclusive. The practical method is to grow plants of the legume host in the soil under consideration. The intensity of the inoculation will be indicated by the number of nodules developing.

If the organisms are found to be present in a soil which is well drained, in good tilth and neutral, there is every reason to believe that an application of legume bacteria of the same strain would be of no appreciable value to a crop of the legume. There are instances of increased production caused apparently by the addition of legume bacteria to soils already inoculated but this increase was probably due directly to an attenuated condition of the organisms already present in the soil and indirectly to some adverse soil or climatic condition. It is probably a safe conclusion that if a soil is in proper condition inoculation will remain in that soil in a virile state almost indefinitely.

Where new legume crops are being introduced and in sections where thru conditions the legume bacteria have been killed or reduced to a low virility it is necessary to supply them. There are two main types of inoculating material which are used in farm practices: field soil which is infected with the proper organisms and cultures of legume bacteria growing on artificial media such as nutrient broth, agar or gelatin and sterile soil.

Field soil has been used as a means of transferring legume bacteria for a long time. This method has been generally advised to the exclusion of the other type and experiments have demonstrated that it is usually efficient when used intelligently. Because a legume crop is growing luxuriantly is not always an indication that the soil in which it is growing is inoculated. The efficiency of a soil as an inoculating agency is indicated positively by the number of nodules developing on the root of the specific legume plants growing in the soil. Soil for inoculating purposes should be collected be-

tween the surface of the field and a 4-inch depth. In sandy soil material can be taken with safety from greater depths. The main objection to field soil inoculation has been the unusual bulk of the material needed and its attendant transportation and labor in application. Considerable stress has been laid on the possible distribution of plant disease organisms and obnoxious weed seeds by soil transfer. This objection is, in a large measure, precautionary; soils from sections distant to the points where it is to be used should be considered carefully in reference to this. Moreover, soil from a local point is not likely to introduce diseases that are not common to the section and the same statement applies to the introduction of weed seeds.

Inoculating material of the soil type may be applied in various ways. It may be broadcasted over the field and harrowed or brushed in to prevent undue exposure to the rays of the sun. A common method is to distribute it thru the fertilizer box of a drill or thru the supply box of a lime spreader. In any method of application, the material should be covered as soon as possible. These methods of distribution are more for the inoculation of the soil for the reception of the seed and are classed as soil inoculation methods. When the amount of available soil is limited it is advisable to screen it, mix it with the seed and sow the mixture. A method which has been reported to have been used with considerable success in the corn belt, especially with small seeds, consists in moistening the seed with a solution of glue so that as far as possible each seed will have a sticky surface. Powdered field soil is worked in with the seed until each one is at least partially covered with soil. The seeds are then dried in the absence of direct

sunlight and after drying may be planted. Care should be taken in the selection of a glue containing no substances deleterious to the organisms. These two methods may be classified under the heading of seed inoculation.

The other type of inoculation or means thru which inoculation is transferred is the pure culture method. The earlier attempts at the production of pure cultures of legume bacteria for farm use resulted to a great extent in failures and much antagonism to their use was developed. With the improvement of pure cultures made in recent years, however, the opposition to their use has practically died out and at present pure cultures are generally considered reliable. Intensity of inoculation and ease of application are the main points in favor of pure cultures. The organisms are obtained in pure cultures from the nodules by laboratory processes and cultivated on sterile artificial food. Practical tests will indicate the efficiency of pure cultures. Pure cultures are generally for seed inoculation altho they may be adapted for soil inoculation by adding to the soil.

A culture growing in nutrient broth or liquid allows for extreme ease of application; it is added to the seed and "worked in" so as to have each seed moistened; after drying, the seed is ready to be planted. These organisms

apparently do not occur in such large numbers per unit of material in broth as they do in other media but this does not necessarily influence their inoculating efficiency.

The agar or jelly like culture as they are usually received by the farmer are prepared for use by adding water and possibly some sugar to the container and then shaking a few minutes to obtain a suspension of the organisms. This suspension is applied in a similar manner to the broth culture. Usually agar cultures contain more organisms per unit of material than broth card cultures. This, however, is dependent mainly on the character of the nutrient substances in the agar.

Sometimes sterile soil or soil mixtures are used as media for the propagation and transfer of these organisms. These cultures are usually mixed with water to obtain a suspension of organisms with which to moisten seed. That soil is the natural habitat of the legume organism is the main point in favor of this method. These cultures live over a long period of time and retain their virility somewhat better than those in other media.

With an assurance that both types of inoculating material have the ability to produce nodules on the roots of the legumes for which they are intended the question narrows to a consideration of local conditions.



EFFECT OF FERTILIZERS ON NITROGEN IN SOILS

Factors to Be Considered in Maintaining the Fertility of the Land

ROBERT M. SALTER, University of West Virginia

ALL prosperity in agriculture rests upon the foundation of a fertile soil. The problem of how to produce large crops most economically, without depleting the fertility of the soil, is centuries old, but today remains unsolved. This, despite the fact that since 1804, when the French scientist De Saussure first gave to the world a basis for the modern theory of plant nutrition, thousands of experiments have been directed towards its solution. That permanence in agriculture must involve the restoration to the soil of a portion of those "elements of fertility" removed by growing crops has been as definitely proven as most facts in experimental science. The question today is, "How may this be done most profitably?"

Of the three elements of fertility, nitrogen, phosphorus and potassium, which most frequently limit the growth of crops, nitrogen is the one used by plants in largest amounts, the one most easily lost from soils and the one most costly to replace in the form of commercial plant food. To grow a 75 bushel crop of corn takes from the soil 105 pounds of nitrogen, 12 pounds of phosphorus and 35 pounds of potassium. To replace these elements in the form of commercial fertilizers would cost at normal prices \$2.00 for potassium, \$1.50 for phosphorus and almost \$20.00 for nitrogen.

When it is considered that nitrogen supplied in the form of fertilizers is rapidly lost by leaching, experiments indicating a possible recovery by the crop of about 50 percent of the nitrogen from such materials as nitrate of soda, it is readily seen that any system

attempting to replace this element by the use of commercial nitrogen alone is practically impossible. Evidently we must look elsewhere for a source of this element with which to keep our soils productive.

A livestock system of farming makes possible the recovery of some two-thirds of the nitrogen in the crops grown, providing these crops are fed and the manure carefully handled. This in itself, however, can only serve in postponing the day of ultimate soil exhaustion. Neither does the fact that the air above each acre of soil contains over 50,000,000 pounds of nitrogen, furnish the solution, it having been finally settled by the English investigators. Lawes and Gilbert, nearly 50 years ago that plants are not able to directly use this form of the element. It suggests, on the other hand, that an economical means of transforming free nitrogen into a form available to plants is all that is needed to a solution of the problem.

The time is not long past when men were accustomed to think of the soil as a mere mass of rock fragments and dead particles of organic matter, the remains of former plants. It is infinitely more than this, every fertile soil is teeming with the life of countless millions of small plants called bacteria. Every clod is an empire, an ounce of ordinary soil often contains more inhabitants than does the whole United States, while the types, activities and requirements of these tiny workers are even more varied than are those of our human family.

The most modern phase of soil investigation has concerned itself with the

study of the habits and requirements of these microscopic plants. That several forms are able to penetrate and grow within nodules which they cause to be formed on the roots of leguminous crops, such as clover, soybeans and alfalfa, was first discovered in 1886 by two German investigators, Hellriegel and Wilfarth. They showed that these bacteria can take free nitrogen from

A great variety of bacterial forms are known to function in the various stages concerned in the process of decay. To this process we owe the change of "organic" nitrogen, and practically all the nitrogen of soils, as well as that left by nitrogen fixing bacteria as "organic" nitrogen, into soluble nitrate nitrogen. This is believed to be the only form of the element ordinarily



Plot 21—No Fertilizer.
100 lbs. Hay.



Plot 21—Lime and Fertilizer.
5,800 lbs. Hay.

Clover at the West Virginia Experiment Farm in 1915—Nitrogen "Fixed" by Increased Clover Crop Represents Indirect Value of Fertilizers and Lime

the soil air and change it into a form available to their host plants. Such crops often gather large amounts of free nitrogen and even leave the soil richer in this element than before their growth.

An interesting group of soil bacteria are those "free living" forms which have more recently been shown to possess this same power of using or "fixing" atmospheric nitrogen. The more important types of these have been called *azotobacter*.

used by higher plants. This transformation has been called "nitrification."

Experiments show that bacteria resemble higher plants in requiring a supply of nitrogen, phosphorus and potassium and other inorganic elements, as well as oxygen, hydrogen, carbon and a source of energy. They vary greatly among themselves in the amounts and forms of these elements which they can use and in their source of energy. Some are able to grow quite well in acid soils, which the activities of others,

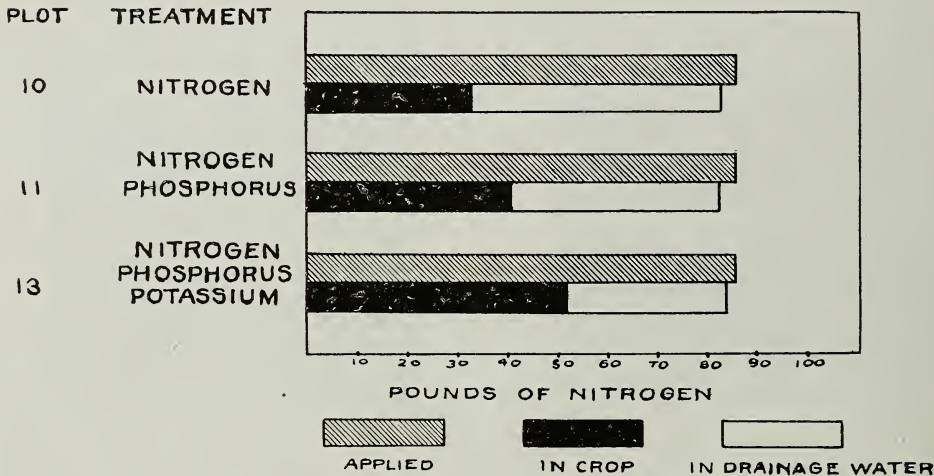
as those causing nitrification, may be retarded by even a slight acidity. These facts suggest that it might be possible to control the conditions in a soil that nitrogen fixation would proceed at a rate sufficient to maintain the nitrogen of the soil and at the same time allow for the transformation of enough organic nitrogen into soluble form to permit the growth of maximum crops.

Too great a change of nitrogen into a soluble form results in the loss of that present in excess of the amount the

while the loss by drainage was proportionately lessened.

Some of the recently published results of the West Virginia Agricultural Experiment Station show the residual effects which 15 years use of fertilizers, lime and manure have had on the nitrogen content of the soil at that station. The soil studied was a silt loam, naturally well drained but of rather low fertility, and an acid soil having a limestone requirement of about 3500 pounds per acre to plow depth.

BROADBALK WHEAT FIELD — ROTHAMSTED



crop can use. That this is true, and also that the amount which the crop can use depends on how favorable other conditions are made for its growth, this is shown by the results of the Rothamsted Experiment Station of England given in the diagram.

Of the 86 pounds of soluble nitrogen applied to these plots, part was used by the crop and the remainder largely lost thru the drainage water. When phosphorus and potassium fertilizers were applied the yield of grain and the utilization of nitrogen were increased,

A variety of crops including three legumes were grown during the 15 years. All crops are removed from the land. The soils of the plots receiving no treatment showed little change in nitrogen content during the experiments, there being in fact a slight increase, indicating a normal fixation of sufficient nitrogen to permit the growth indefinitely of such poor crops as were raised on these plots. The yield of the treated plots, the nitrogen present in the soil at the end of the 15 years in excess of that in the corre-

sponding untreated plots, the amount of nitrogen removed in the crops on the treated plots in excess of the untreated plot, the amount of nitrogen applied, and the difference between the total gain in soil and crop and the amount of nitrogen applied is shown in the table. This difference represents the extent to which nitrogen fixation has overbalanced the loss by leaching from these plots.

crease in nitrogen to the direct effect of the fertilizers themselves on the bacterial processes. Since only three legumes were grown and these completely removed, any accumulation of nitrogen we believe to be in large part due to increased activity of the free living nitrogen gatherers.

Several facts stand out prominently in these results. Nitrogen used alone has resulted in a loss from the soil of

RESULTS OF FIFTEEN YEARS' EXPERIMENTS AT THE WEST VIRGINIA EXPERIMENT STATION

Plot	Treatment.	Total Produce pounds per acre.	Nitrogen Gain in Soil over check pounds per acre.	Nitrogen Gain in Crop over check pounds per acre.	Nitrogen applied pounds per acre.	Nitrogen Gain in Soil and Crop less Nitrogen applied pounds per acre.
19	N, P, K, Lime....	120,600	679	833	672	840
26	N, P, K.....	117,900	1034	637	672	1099
20	Manure, Lime....	152,400	1301	1069	2100*	270
25	Manure	139,700	1743	940	1900*	783
22	Lime	36,615	—232	—7	0	—239
28	P, K.....	77,000	815	358	0	1173
29	N, K.....	52,200	460	64	672	—138
31	N, P.....	95,900	274	611	672	213
32	K	41,600	—90	21	0	—69
34	P	63,400	25	270	0	295
35	N	41,200	—253	35	672	—890

*Calculated Values. N=Nitrogen. P=Phosphorus. K=Potassium.

In considering these results it should be remembered that a given fertilizer treatment may operate by favoring either the nitrogen fixing or the nitrogen transforming bacteria, or both; also by increasing the ability of the crop to utilize the soluble nitrogen applied or resulting from the process of nitrification. Mention should also be made that there has been an accumulation of organic matter in the soils of the fertilized plots, and except on the limed plots this has been roughly proportional to the increase in crop yield.

Organic matter serves as a source of energy for the free living nitrogen fixing bacteria; hence, we are probably not warranted in attributing all in-

even more nitrogen than was applied. The crop, being limited by other factors, could not use the nitrogen added. Wherever phosphorus has been used we find that increased nitrogen fixation has taken place, amounting to 295 pounds per acre, or nearly 20 pounds per year where used alone, and to 1173 pounds per acre or 78 pounds per year when used with potassium. Seventy-eight pounds of nitrogen in the form of commercial fertilizer would cost about \$15, over three times the cost of the fertilizer applied to this plot.

In all cases phosphorus has resulted in increasing the power of the crop to use available nitrogen and has apparently favored both nitrogen fixing and

nitrogen transforming processes. The effect of potassium has been more noticeable on the increased fixation in the soil than it has on the utilization by the crop, being more favorable to fixation apparently than to nitrification.

Nitrogen, next to phosphorus, is probably the most needed element on this soil. Its use in addition to phosphorus and potassium has produced a larger yield resulting in an increased utilization of nitrogen. It has apparently not greatly affected either the

tent its effect has been due to this fact cannot be determined.

The general conclusion may be drawn from these results that the effects of fertilizers on this soil may be in part an indirect result of their effect on the bacterial activities. That phosphorus and potassium favor the accumulation of nitrogen in soils, while phosphorus in particular increases the power of the crop to utilize soluble nitrogen and that lime on this acid soil intensifies the rate of nitrification.



A Good Crop of Alfalfa Adds Nitrogen to the Soil

process of fixation or that of nitrification

A comparison of the limed plots with the corresponding unlimed plots shows that there has been a loss of nitrogen in all cases due to the use of lime, amounting to 239 pounds where used alone, to 259 pounds where used with complete fertilizers, and to 513 pounds where used with manure. Since other experiments indicate that the fixation of nitrogen is not lessened by the use of lime, this effect has probably been due to an increase in nitrification. The total quantity of lime used on these plots has been considerably in excess of the needs of the soil. To what ex-

Since we are not interested in an accumulation of nitrogen in the soil except as it can be made available to crops, it would seem that best results might be expected from the use of lime in addition to phosphorus, containing organic matter which serves as a source of food for the nitrogen fixing bacteria. Hence, it should serve as an ideal source of potassium for these organisms. The growing of legumes also adds to the amount of nitrogen fixed.

These and other experiments suggest that the solution of the nitrogen problem, and with it the guarantee of permanence in agriculture lies in the proper use of phosphorus, manure;

lime and legumes. The more closely this result is approached, the more nearly does it agree with Justus Liebig, the father of agricultural chemistry, who wrote in the Farmer's Magazine in 1843, "If the soil be suitable, if it

contain a sufficient quantity of alkalis, phosphates, and sulphates, nothing will be lacking. The plants will derive their ammonia (nitrogen) from the air as they do carbonic acid."



Bacteria Grow in Nodules on the Roots of Legumes. They Help Solve the Nitrogen Problem by Taking Nitrogen From the Air

NITROGEN FIXATION INDEPENDENTLY OF LEGUMES

Results of Experiments Show Increase in Soil Without Nodule-Bearing Plants

FIRMAN E. BEAR, Department of Soils, Ohio State University

SOMETHING over a century ago, Sir William Crooks, president of the British Association for the Advancement of Science, made the startling prediction that the world must cease growing wheat before the end of another 50 years because of the exhaustion of the supply of nitrate of soda in the South American deposits. Coming from a man of his standing the statement was considered authoritative. This was previous to the development of the science of bacteriology in its relation to soils. It was not until almost the close of the last century that Hellriegel and Wilfarth definitely proved that the nodules on the roots of legumes were the homes of a great number of organisms which were able to secure nitrogen from the inexhaustible supply of the air.

In 1893 and again in 1901 two important bacteriological discoveries were made. Subsequent investigations have confirmed these discoveries and have shown that practically all soils contain bacteria which live independently of legumes and are able to fix atmospheric nitrogen for the use of higher orders of plants.

The question in which practical farmers are more vitally concerned is as to whether it is necessary in well organized systems of soil improvement to purchase nitrogen in the form of commercial fertilizers to make good the loss in crops and in the drainage water. In other words, can we secure sufficient nitrogen from the inexhaustible supply in the air to maintain the nitrogen content in the soil.

Some years ago, A. D. Hall, then Director of the Rothamsted Agricul-

tural Experiment Station, at Harpenden, England, called attention to some analyses which had been made at two different periods of the soil of the Geescroft field on the Rothamsted Experimental Farm. This Geescroft field had been under experiment for a number of years. A part of the field was allowed to run wild in 1883 and whatever vegetation grew on the area from that time was left to fall down and return to the soil. At the time this part of the field was abandoned, it was in clover but this clover soon disappeared and was replaced by plants which belonged almost entirely to the non-legumes. In 1904 the soil was again sampled and analyzed for nitrogen. This sample, as well as the previous sample, was taken from the soil to a depth of 27 inches.

By comparison with the analysis made in 1883 it was found that the soil had gained a considerable amount of nitrogen, much more than could be accounted for by the clover crop, which had grown on the land during the first few years after the area was abandoned. Discussing these analyses, Director Hall asked: "How comes it that the Geescroft land, with no plants growing on it which are capable of fixing free nitrogen, has yet gained an enormous quantity of nitrogen during the 20 years under review, a quantity which, at the lowest reckoning amounts to 25 pounds per acre per year? The nitrogen brought down in the rain would account for perhaps 5 pounds per acre per annum and a little more will come in the form of dust, bird droppings and other casual excrements."

This statement does not take into

consideration the fact that a certain amount is lost each year in the drainage water or may be lost by denitrification into the air. Taking all these things into consideration, it will be seen that a considerable amount of nitrogen must have been secured from the air during this period of 20 years which cannot be accounted for on the basis of the bacteria growing in association with legumes.

Thru C. G. Williams, agronomist at the Ohio Experiment Station, some of the soil from the station farm was obtained for experimental purposes. Four hundred grams of this soil was weighed, thoroly mixed, and a sample chosen for analysis. The remainder of the 400 grams was placed in a shallow dish, and treated with acid phosphate and limestone at the rate of 2000 pounds of the former and 7500 pounds of the latter per 2,000,000 pounds of soil. This amount of soil would cover an acre to a depth of about 7 inches. Eight grams of sugar were then thoroly mixed with the soil, water added to the optimum and the soil was set aside at a temperature of about 25°C. Each day the soil was thoroly mixed and the moisture lost by evaporation was restored. At the end of 21 days the soil was again carefully mixed and a sample again chosen for analysis. These analyses showed that in 21 days

nitrogen amounting to 320 pounds per acre of 2,000,000 pounds had been added to the soil.

The only possible source of this nitrogen was the air as the soil was entirely bare of vegetation. This experiment is typical of many experiments along this line which have been conducted with many soils. Such large amounts of nitrogen would not be fixed under field conditions, probably, even if the sugar, acid phosphate and limestone were supplied. But the results of the analyses of the soil of the Geescroft field indicate that nitrogen fixation is taking place in no inconsiderable amounts even under field conditions.

Three groups of the bacteria which bring about this nitrogen fixation are known. One member of the first group is known as *Azotobacter chroococcum*, an aerobe. A member of the second group is named *Clostridium pasteurianum*, an anaerobe. The third group is made up of the various species of *Bacillus radicola*, the same organisms which produce nodules on the roots of legumes, but which have also been shown to be able to fix atmospheric nitrogen independently of legumes. Experimental work along this line is now being carried on at many agricultural experiment stations thruout the United States.



INCREASING THE NITROGEN IN SOILS WITH LEGUMES

Experiments Show That It Can be Secured from Air in Considerable Amounts

GEORGE M. McCLURE, Department of Soils, Ohio State University

THE value of legumes as soil improvers has been recognized for several centuries. In Roman literature, mention is made of the Roman farmers regarding beans as possessing the property of enriching the soil. Alfalfa and vetch were also observed to possess this property.

Just why legumes, and not other spe-

cial amount of nitrogen gained by soils when legumes are grown on them.

In an experiment at Rothamsted, a piece of land which had been cropped for 5 years by cereals without the addition of any nitrogenous manure, was divided into two parts in 1872. One portion was sown to barley alone, and the other to clover and barley. The



Effect of Soil Rich in Nitrogen

cies of plants, were beneficial in this regard, was not understood until 1886 when Hellriegel and Willfarth showed that legumes added nitrogen to the soil from the air, thru the aid of the bacteria associated with them on their roots.

This ability of legumes to utilize atmospheric nitrogen is now generally recognized. This has been due in part to persistent teaching and in part to experimental evidence showing the act-

following year barley was again sown on the one portion and clover on the other. The third year barley was sown on both portions of the field. It was found that the third crop of barley from that portion of the land on which no clover was grown removed 39.1 pounds of nitrogen per acre while the barley which followed the clover removed 69.4 pounds of nitrogen per acre. Thus the barley which followed the clover obtained 30.3 pounds more of

nitrogen per acre than the barley which followed barley. An analysis of the soil was made in 1873 which showed an excess of nitrogen amounting to 300 pounds per acre in the land which had been cropped to clover, even tho the previous clover crop had removed 114 pounds more of nitrogen per acre than the barley crop.

In another experiment at Rothamsted, land which had lain in fallow for 5 years was sown to barley and clover, the clover being allowed to stand the second and third year. At the beginning of the experiment the soil was found by analysis to contain 2657 pounds of nitrogen per acre to a depth of 9 inches. It was found by analysis of the crops, that 320 pounds of nitrogen per acre were removed by them in 3 years, yet the soil contained, at the end of the experiment, 2832 pounds of

stand. The soil at the beginning of the experiment showed, by analysis, a nitrogen content of 533 pounds per acre. After 5 years the soil contained 841 pounds of nitrogen per acre, and at the end of the 10 years the amount of nitrogen in the soil had increased to 1044 pounds per acre. In other words, there was an increase of nitrogen in the soil, due to the 10 years growth of clover, of 511 pounds per acre, or 51.1 pounds per acre per year. If the amount of nitrogen lost in the drainage water during the 10 years is considered, the total increase of nitrogen due to clover would be considerably higher.

The following table shows the results of some experiments conducted at the Rhode Island Agricultural Experiment Station on the fixation of nitrogen by legumes:

Crop	Pot	Nitrogen in Soil and Seeds Be- ginning. Pounds per acre.	Nitrogen in Soil and in Crops Re- moved, End. Pounds per acre.	Net Gain in Nitrogen. Pounds per acre.
Soy Beans	1.....	4367	6222	1855
Soy Beans	2.....	4273	6094	1821
Soy Beans	3.....	4273	6157	1884
Soy Beans	4.....	4345	6165	1820
Cow Peas	5.....	3821	6023	2202
Cow Peas	6.....	3888	6086	2198
Cow Peas	7.....	3709	5732	2023
Cow Peas	8.....	3807	6006	2196
Average		4060	6060	2000

nitrogen per acre to a depth of 9 inches. In short, the amount of nitrogen in the soil was increased by 175 pounds in the 3 years, and taking into consideration the amount of nitrogen removed in the crops, there was a total gain for nitrogen of nearly 500 pounds.

At the Canadian Experiment Farm at Ottawa clover was grown continuously on the same plot for 10 years, each year's crop being cut and allowed to decay on the plot. The clover was reseeded every 2 years to insure a good

The soy beans and cow peas were grown every summer for 5 summers, the crops being harvested and removed. Vetch was grown each winter as a green manure crop and turned under. The experiment was conducted in pots containing 52 pounds of soil but the results have been calculated to the acre basis. The gain in nitrogen was approximately 2000 pounds per acre for 5 years, or 400 pounds of nitrogen per acre per year.

At the Michigan Agricultural Experiment Station a comparison was made

of the amount of nitrogen fixed by legumes with and without nodules on the roots. With soy beans, it was found that those plants which developed nodules accumulated 38 pounds more of nitrogen per acre than those

ductive power is obtained from the air. These figures were obtained by analyzing inoculated and uninoculated legumes from similar areas of normal soils. The following is a summary of their experiments with alfalfa:

Average of all Tests.	Pot Experiments. Nitrogen Pounds per acre.	Field Experiments. Nitrogen Pounds per acre.
Uninoculated	33.3	27.8
Inoculated	69.4	73.0
Gain for Inoculation.....	36.1	45.2

without nodules. Cow peas with nodules showed a net gain in nitrogen of 21 pounds over those without nodules.

Data published by the Illinois Agricultural Experiment Station indicates that two-thirds of the nitrogen in legumes grown on soils of normal pro-

These results, taken as a whole, present undeniable proof that nitrogen can be secured from the air and in considerable amounts. It also may be concluded that the growing of legumes will be of material benefit in maintaining the nitrogen supply of the soil.



Nodules on Roots of Legumes

SHOULD WE GROW ALFALFA IN OHIO?

Considerations in Establishing the Crop in the Rotation

WALLACE E. HANGER, Extension Department, Ohio State University

THE slogan, "Alfalfa on every farm in Ohio," has often been heard. Is this to be wished, or should it be frowned upon?

It is true that there is a real interest in alfalfa over the entire state, an evidence of which is the rapidly increasing acreage during the past few years. From "Ohio Agricultural Statistics" for 1914-15 it is seen that in 1905 there were 10,800 acres grown in Ohio; in 1910, 23,500 acres; in 1911, 25,000 acres; in 1912, 27,700 acres; in 1913, 47,800; and in 1914, 60,500 acres. Information concerning the acreage grown since 1914 is not available, but quite likely the rate of increase since 1912 has been maintained.

From the same source it is found that the average production of hay is a trifle more than 2 tons per acre. The increase in acreage is not due to a greater interest in certain localities in the state but to a general effort being put forth in nearly every county.

In fact, it may be said that it is becoming fashionable to grow alfalfa. Some men grow alfalfa because it fits in with their scheme of farming, is well adapted to their land, and is a success on their farms. Other men are attempting to grow alfalfa because some acquaintance of theirs has succeeded, but they may be overlooking the fact that conditions of soil, climate, and the general scheme of farming are entirely different. Still other men are growing alfalfa in order to demonstrate their ability to succeed with this crop where others failed.

There is no doubt that alfalfa is a valuable crop and has an important place in sections where it is adapted.

It is valuable because of its ability to secure nitrogen from the air, drouth resistance, high nutritive value and palatability, large yields and long life.

While alfalfa has the ability to secure nitrogen from the air, it perhaps is not superior to red clover in this respect provided both grow equally well.

Alfalfa has a deeper root system than any other crop grown and is better able to secure an ample supply of moisture when other crops suffer. Alfalfa makes a palatable hay and has a high nutritive value, but feeding experiments conducted at several experiment stations over the country do not show that it is decidedly, if any, better in this respect than red clover hay.

Alfalfa often produces 3 tons or more of hay per acre, but, as grown in Ohio, the best data available show that only a little more than 2 tons are produced. Because alfalfa is a perennial, it is considered a long-lived crop. However, it is a fallacy to believe that it can be grown indefinitely without reseedling. The average length of life for alfalfa fields in Ohio is not more than 4 or 5 years.

On the other hand, there are some disadvantages in growing alfalfa. In the first place the climatic conditions are rather unfavorable for best results with alfalfa in Ohio. This is shown in the fact that alfalfa produces little seed in this state, and certainly one of the laws of nature is that plants make this provision for reproducing themselves. Alfalfa winter-kills rather easily in Ohio. In the July number of the monthly bulletin published by the Ohio Agricultural Experiment Station at Wooster is found an article by C. A.

Gearhart telling of investigations concerning the winter injury to alfalfa, red clover, mammoth clover, and alsike clover in Ohio during the winter of 1915-16.

Data collected in this investigation from more than 60 percent of the counties in the state reveal the fact that over 40 percent of the alfalfa seeded in the summer of 1915 was winter-killed. Similar data showed that only about 20 percent of the red clover was winter-killed. Because alfalfa is a rather difficult crop to grow, unusual efforts are put forth in preparing a good seed bed. This often means that the use of the land is practically lost for one season. Hence, this makes the crop an expensive one to establish.

Alfalfa does not fit in nicely to the usual rotation owing to the fact that it is a perennial. On account of the difficulty encountered in securing a stand, it is generally allowed to grow on a piece of land as long as it will produce a fairly good crop of hay. This practice may lead to soil exhaustion unless plant food is returned to the soil in the form of commercial fertilizers or barnyard manure, since alfalfa requires considerable amounts of phosphorus and potassium along with the nitrogen that it secures largely from the air. Instead of alfalfa being a soil builder as it is ordinarily called, it is possible to conceive of it helping to exhaust the fertility of the soil.

Alfalfa seems to be exacting in its soil requirements. Several conditions necessary are good drainage, fair degree of fertility, freedom from weeds, an abundance of lime, and the presence of the proper bacteria in the soil.

Alfalfa flourishes nowhere as well as on naturally drained land. In some sections of Ohio there are considerable areas where the top soil is underlaid with gravel or gravelly layers. This

furnishes excellent natural drainage, and no trouble is usually found in growing alfalfa successfully under such conditions.

As a general thing it is found that land which is too poor to produce fairly good yields of the ordinary field crops will not grow alfalfa successfully. There seems to be an idea that is more or less prevalent that the way to restore fertility on wornout lands is to grow alfalfa upon them. Doubtless this would be effective if it could be done, but it is not usually profitable to attempt to do so.

Summing up the situation in Ohio it would seem that alfalfa has a rather important place and can be of great help in certain sections where it is well adapted. Alfalfa is being grown with success in large areas in western and southwestern Ohio with apparently little more effort in securing successful stands than is required to grow red clover. Under such conditions there is no doubt but that it will perform an important function.

In a greater part of the state, it is usually necessary to make rather heavy applications of lime, spend considerable amounts of time and money in various ways to build up the fertility of the soil and in preparing the seed bed, supply inoculating material either for soil or for seed, and finally lose the use of land for practically one year in getting the crop started. Even then the chances for securing a successful stand are about evenly divided. Hence, it seems that with the exception of such areas as referred to above, it will be for the ultimate good of Ohio agriculture if considerable more time, energy, and money be spent in getting land in condition to grow red clover successfully. It is, therefore, the logical conclusion that alfalfa does not or should not have a place on every farm in Ohio.

POSSIBILITIES OF SWEET CLOVER ON THE FARM

Crop Commonly Called a Weed Furnishes Large Amounts of Honey and Feed

ANDREW S. WING, Mechanicsburg, Ohio

UNTIL within recent years sweet clover was considered a rank weed by most farmers. Today it is welcomed by the progressive agriculturist as a pasture plant without a peer. It is staunchly maintained by men who have had several years experience with sweet clover as a pasture plant, that an acre of sweet clover will furnish more forage of a highly nutritious nature than will any other pasture crop.

In spite of its bitter taste, all kinds of stock soon learn to eat it and will in fact leave other pasture for it if it is available. Its high protein content makes it very nourishing and at a conservative estimate, under normal conditions an acre of sweet clover may be expected to furnish pasture for one head of cattle thruout the growing season, and for other livestock in relative proportion. Instances have been known where sweet clover fields have furnished more feed than this, but when it is considered that it usually requires several acres of first class blue grass pasture for one steer, a steer to an acre looks pretty good.

All kinds of live stock love this vigorous growing legume. Horses and sheep thrive on it and I have seen pigs keep it eaten down to the ground while at the same time they were making splendid gains. Nor does there seem to be as much danger of bloating as with alfalfa altho some cases of bloat have been noticed where cattle were put on sweet clover pasture. Never had the cases noticed developed a dangerous degree of bloat and the attacks worked themselves off naturally without any medical or surgical aid.

In some localities considerable diffi-

culty has been had in obtaining a good stand of *Melilotus*. In many other places no trouble at all is experienced and the plant will seed itself from year to year almost indefinitely if it is so allowed. There are a few things that must be borne in mind when sowing sweet clover. In the first place it must have lime in the soil if it is to live at all. In this respect it is like alfalfa and like alfalfa it must have inoculation, the same bacteria growing on its roots that are found on the roots of the alfalfa plant.

Sweet clover will grow on a soil that is apparently barren and lacking in humus providing there is an ample supply of lime in the soil. Thus we often see it growing in the gravel ballast along railroad tracks or along pikes where the lime dust has washed or blown out into the roadside. *Melilotus* will also grow in a wetter soil than will either red clover or alfalfa.

There are three varieties of sweet clover, a yellow and a white blooming biennial and a small yellow blooming annual. Experience has shown that for practical purposes the taller, white blooming *Melilotus alba* is best and little seed of the other is now sown. Winter or spring seeding is customary and good results are obtained with both altho where the seed is covered naturally by the action of the frost a better stand is usually obtained.

Sweet clover seed is slow to germinate due to the hard seed covering and the presence of many "hard seeds." For this reason unhulled seed should never be used and if the seed is sown in the spring it should be "scarified" or literally scratched by a sand paper-

ing machine which wears down or breaks open the hard outer coat. It seems to be always best for sweet clover to have a hard seed bed.

The *Melilotus* may be pastured the first year as soon as the plants have had time to make a fairly vigorous growth. A hay crop may also be harvested the latter part of August or first of September. When cutting for hay the mower knife should be set high as there is danger of killing the plants if they are cut too low. The new shoots do not come from the crown as with alfalfa but from the stalk and if the stalk is cut too low it may not sprout again.

As a hay crop sweet clover is rather a disappointment as the stems are rather coarse and hard to cure and usually most of the leaves drop off before the stems can be cured out. Its main forte seems to be used for pasture and a soil improver. The thick, branching roots will quickly add considerable nitrogen to a poor, worn soil where

nothing else will grow, providing of course there is plenty of lime there.

Sweet clover will not bloom the first year but will bloom abundantly the following year and will form usually a large amount of seed. The seed is a profitable crop to save but also a difficult and uncertain one because it shatters easily and must be handled carefully. As soon as it is 6 inches high in the spring stock may be turned on it and allowed to run all summer unless it is desired to gather a seed or hay crop, when they should be shut away about the last of July and the seed crop allowed to grow.

Quite often the sweet clover will reseed itself, but otherwise it dies out at the end of the second year. There is no danger of the plant becoming a weed or a pest in cultivated fields or pastures because repeated close mowings or plowing is sure to kill it. Along the roadside it is too pretty to be called a weed and it furnishes large quantities of honey for the bees.



The Last Cutting of Alfalfa on the Farm of George Wilbur of Marysville.

THE PROBLEM OF SOIL ACIDITY

Solution Will Come Only With Exact Information as to Its Causes and Nature

SIDNEY BLISS, '17

THO acidity in the soil is known to exist, our explanations of it are far from conclusive. There are numerous simple methods for the detection of soil acidity, such as the action of soil upon certain indicators like litmus paper, and also methods for the calculation of the lime requirements of soils.

sorb, and calculating the amount of calcium oxide from the results. Truog's Test is based upon the action of the acid soil on zinc sulfide, hydrogen sulfide being liberated in amount corresponding to the acidity of the soil, and the degree of acidity is calculated from the resultant coloration of strips



Growth on Left Due to Lime

The question is, "Are these tests accurate?"

Among the best known tests for soil acidity are those of Veitch and Truog. To test for acidity by the Veitch Method, a sample of soil is extracted with water, the extract is boiled and phenolphthalein is added as an indicator. The test may be made quantitative by determining the amount of calcium hydroxide that the soil will ab-

of paper moistened with lead acetate.

The generally accepted litmus paper method of testing for soil acidity is considered of doubtful value by some careful investigators. J. A. Bonsteel, of the United States Department of Agriculture, has said that little can be said in favor of the litmus paper test for soil acidity, and that much can be said against it. However, some prominent men are found in soils work, who do

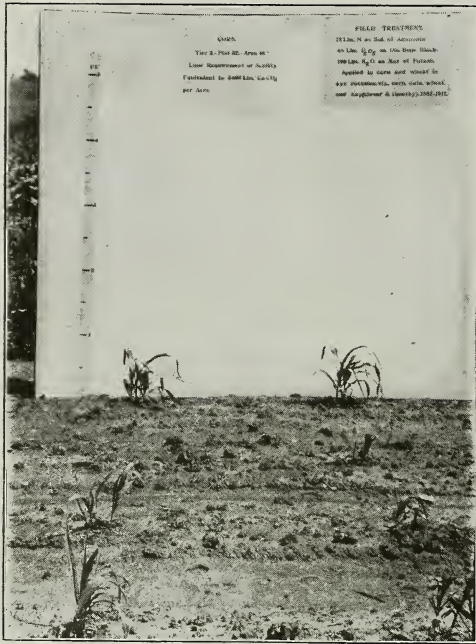
recommend this litmus paper test. That equally conscientious men should disagree in the interpretation of the same results, lends interest to the further work that is being done on this subject at the present time.

As to soil acidity, men who are working on the problem are in substantial

and not to the selective ion adsorption by colloids."

There are many causes which have been assigned to soil acidity. In soil making rocks lose largely of their basic materials, and this loss is actual in the soil. Of these basic substances, lime is lost to the greatest extent. The material excreted by the roots of plants may be acid in character as may be also the earlier products of plant decay. The addition of certain fertilizers such as ammonium and potassium sulfates is known to increase the acidity of the soil and the selective adsorption of the bases by soil colloids also contributes to the acid reaction.

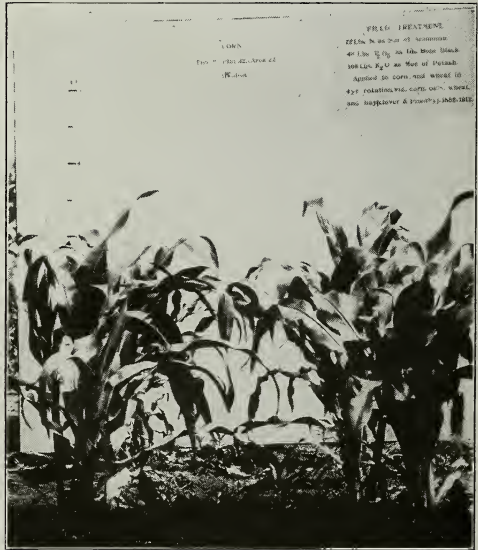
Of the principal crops in the northern United States, practically all, ex-



Failure of Corn Due to Lack of Lime

Courtesy of Professor Gardner, Pennsylvania State College.

agreement as to its nature. Oscar Loew states that acidity in soils, quite free from humus, indicates that soil acidity is inorganic in nature. While he recognizes that organic matter does tend to produce organic acids in the soil, this accounts for temporary rather than permanent soil acidity. Again, it is said that colloids are known to have an adsorptive effect upon the soil solution, taking up bases from the nutrient salts with the liberation of acids. Truog, of Wisconsin, in an article written a short time ago, states that "soil acidity is due to true acids in the soil



Growth Obtained After Liming

Courtesy of Professor Gardner, Pennsylvania State College.

cept potatoes, do best in a neutral or alkaline soil. It is not known just when lime was first applied as an amendment to soils, but it was applied to fields and vineyards for centuries before the modern historical period, and its use has become almost a matter of course, tho

its specific action is still problematical.

Lime has the physical effect upon the soil of modifying its structure, thus altering the temperature, aeration, water movement, and plant adaptability. Chemically, it modifies the weathering of soil particles, liberates other basic substances in the soil, and affects the solubility of mineral phosphate compounds, as well as modifying humus and nitrogenous compounds. Biologically, lime affects plant nutrition, and the kind, number, and activity of the beneficial and harmful soil organisms.

An increase in acidity results in a decrease in the fermentative activity of the soil, while a marked acidity of the medium stops nitrification. Hilgard states that, "In an acid medium, nitrification immediately ceases as it also does whenever the amount of base present has been fully neutralized." At the Pennsylvania Station, highly acid soils were found to contain little more than one-half of the organisms that were to be found in normal soils.

Statements of Oscar Loew in 1901 gave promise of aiding in the explanation of the functions of lime in the soil. He said "that in all cases of great fertility, the soil never shows any marked excess of magnesia over lime, but on the contrary, generally more lime than magnesia. He also affirms that lime

and magnesia can exert their nutritive functions only when they have a certain dependence upon each other. Hence, a certain ratio between these two nutrients will produce the most favorable results, while an excess of one of them will be poisonous or toxic to the plant. He also stated, without proof, the existence of a calcium-protein compound, in plants requiring calcium, in which the base is not replaceable with magnesium without serious injury to the protoplasm.

There are many loams and clay loams in the eastern part of United States where the present lime requirement for the surface soil alone is 4000 to 8000 pounds per acre, and there are, doubtless, clay soils that require even larger amounts. While the obtaining of limestone is not a serious problem in Ohio, there are some sections where the neutralization of acid soils would cost from 20 to 25 percent of the value of the land.

The solution of the problem of soil acidity will only come with more exact information as to the real causes and nature of soil acidity. Further study along the line of establishing an agriculture adapted to acid soils will be an aid in solving the problem where the cost of living is prohibitive.



SHOULD OATS OR SOY BEANS BE GROWN IN ROTATION?

Drawbacks and Advantages Connected With Their Culture

LEONARD HILL, Piqua, Ohio

ALTHO the soy bean has been grown in China and Japan for many centuries, it is a comparatively new crop in this country. Because of the density of the population in those countries, the people are forced to practice the strictest economy. They eat little meat, but obtain the protein necessary to balance their diet largely from products made from soy beans.

It will be a long time, if ever, before the soy bean can have such an important place in American agriculture. Yet, because of its many valuable qualities, the soy bean deserves to be studied closely, to find out whether it would be profitable to put it in a regular rotation. To do this it must either be added to our rotation, or substituted in place of some crop already being grown. A 4-year rotation of corn, oats, wheat, and clover is probably more generally used than any other over a large portion of our country. No doubt, on many farms oats could be dropped from this rotation better than any other crop.

Oats do best in cool weather, while the soy bean is a hot weather plant. Because of this, oats do better in the North and soy beans show to greater advantage in the South. To get the oats in the ground as early as possible in the Spring, the soil is often plowed and worked much sooner than it should be. The normal time to sow soy beans is a little after corn planting. With soy beans in the rotation all the sod ground could be plowed early, which would be to the advantage of the corn crop. The ground could then be plowed for soy beans and this followed by the planting of the corn and of the soy beans.

If the soy beans are planted in rows and cultivated, the corn or soy beans would undoubtedly often suffer for the lack of time to give both crops the proper attention. When soy beans are grown for the grain, most experiments show a slight advantage in sowing them in rows and cultivating them 2 or 3 times, as compared with being drilled solid and not cultivated. According to my own experience, sowing them solid and running a weeder or a light spike tooth harrow over them about 3 or 4 days after sowing, and then again once or twice when the beans are from 3 to 5 inches high has given good results.

The amount of labor required to harvest the two crops does not differ materially and they are usually handled in much the same general way. Four years out of 5 I have cut my soy beans with a binder. The past summer, because of the drouth, the soy beans made such a short growth that they had to be cut with a mower with a clover seed buncher attachment. On rich soil soy beans will not lodge nearly as much as oats. After the beans have stood in the shock or windrow for a few days, they may be threshed directly from the field or hauled into the barn or stacked.

Under all conditions and varieties a regular bean huller is found most satisfactory. By using care in selecting a variety that does not split or crack easily, a common separator can be used with little trouble of broken beans, if blank concaves are used and the speed of the cylinder is somewhat reduced. This care is necessary only when the beans are used for seed.

The labor required to prepare a seed bed for wheat is much more when fol-

lowing oats than soy beans. In the former case, the ground must be plowed and gone over many times to fine and pack the seed bed. This is often hard, slow work during the heat of the summer. After the soy beans are removed, one good double disking will usually make a good seed bed for wheat. On the other hand the harvesting of soy beans often comes about the same time the corn is ready to be put into the shock.

A comparison of the money values that may be derived from oats and soy beans can be gotten by referring to two 4-year rotations being conducted on the Miami County experiment farm. The crops in the rotation are corn, oats, wheat and clover; and corn, soy beans, wheat and clover. The two rotations are grown side by side under similar conditions, as near as possible. The 3-year average yield for oats on unfertilized ground is 44.15 bushels per acre, and 2137 pounds of straw. The 3-year average yield for soy beans on unfertilized ground is 20.58 bushels per acre. The yield of soybean straw is not in the published report but it can be estimated at about 1800 pounds for the above yield of beans. The above yields are in about the proportion one might generally expect from the two crops on the same quality of land.

Fifty cents per bushel is a good average price for oats. Two dollars a bushel can readily be obtained for soy beans in good seed condition. This makes a money value per acre decidedly in favor of soy beans.

Under present conditions and prices the soy bean crop can usually be disposed of to best advantage as a grain crop, yet it can be used in many other ways. If cut when pods are well formed, soy beans make a large amount of nutritious hay with a disadvantage of being somewhat coarse. If put into

the silo at the rate of one load of soy beans to two of corn a better balanced and more nutritious silage will be made than from corn alone. It makes a good soiling crop. Good results have also been gotten by farmers who practiced hogging off the soy beans.

In regard to marketing, the advantages are in favor of oats. Oats being a staple crop there is a market for them in any quantity at all times and in all localities. The demand for soy beans, because of being a comparatively new crop, is not large and is widely scattered. The call for seed is limited mostly to a few months in the spring. Elevators will sometimes handle them, but generally they wish a wide margin on the price. An entire crop can usually be disposed of to some wholesale seed company at a fairly satisfactory price.

Probably the greatest advantage of the soy bean over oats is that it is perhaps the only legume used as a grain crop that can profitably be grown in this section of the country. One of the farmer's chief problems is to keep, at least expense as possible, an abundant supply of the essential elements of fertility in the soil in a readily available form. Nitrogen is one of the essential elements that is likely to become deficient in the soil.

Nitrogen exists in the air and mixed with the soil in inexhaustible quantities. At the same time it is the most expensive element to buy in the form of commercial fertilizers. It is fortunate that among our most profitable crops are those by means of which this free nitrogen of the air can be utilized. It is a characteristic of all legumes that, with proper inoculation, nodules develop on their roots.

Bacteria live in these nodules, that are able to take in the uncombined nitrogen of the air, circulating in the

soil, and combine it with other elements to form compounds of nitrogen, which are suitable for the use of plants. Leguminous plants are thus able to obtain a large part of their nitrogen requirement from this source.

There is approximately 100 pounds of nitrogen in the tops and grain of soy beans that yield 20 bushels per acre. This means that about 30 pounds of nitrogen are obtained from the air for each acre of soy beans grown, yielding 20 bushels per acre. If one third of the nitrogen is contained in roots, stubble and leaves left on the ground, then the stock of soil nitrogen would not be depleted any for having grown a crop of soy beans.

On the other hand the amount of nitrogen contained in oats and straw would represent just that much removed from the soil, and would amount to about 43 pounds for a 44 bushel crop of oats. Then, besides, the 1800 pounds of soy bean straw used in bedding would return to the land in manure $2\frac{1}{2}$ times as much nitrogen as the 2137 pounds of oat straw. By growing legumes whenever possible, a readily available supply of nitrogen in the soil is maintained or increased to the advantage of each crop in the rotation.

Another advantage of substituting soy beans for oats is the chance to use a cover crop after corn to better advantage. On account of the desirability of sowing the oat crop early in the spring, the cover crop whatever it may be has so little chance for growth that it is doubtful whether it pays to sow one. By plowing later for soy beans, the cover crop makes more growth and consequently increases its value in adding organic matter to the soil. This is a

matter of considerable importance in maintaining or increasing the productivity of the soil.

How this apparent advantage in regard to fertility works out in practice and to see if it has any influence on the other crops in rotation is shown in the two rotations mentioned above. The average unfertilized yields for rotation containing oats and the other soy beans are as follows: For corn 47.65 and 53.99 bushels; for wheat 16.27 and 19.30 bushels, and clover 1762 and 2847 pounds per acre. Counting corn at 60 cents per bushel, wheat at \$1.20 and clover at \$10.00 per ton, this would make a difference of \$11.05 in valuation of the three crops in the two rotations. When equal amounts of commercial fertilizer are applied to the two rotations a further advantage is shown in the rotation containing soy beans. That is, the increase of crops over and above the cost of fertilizer is more in the soy bean rotation. The above results are calculated from a 4-year average for corn, 3-year average for oats and soy beans, 2-year average for wheat and a one-year average for clover. Considering the short duration of the experiment, it would be well to look at it as an indication rather than as conclusive evidence.

These are a few of the common drawbacks of soy beans which may be largely overcome and also some of the advantages to be derived from their culture. No doubt many farmers in different sections of Ohio could substitute soy beans in place of oats and derive more profit from them and at the same time they could continually be increasing the fertility of the soil.

GROWING RED CLOVER IN THE ROTATION

Produces Large Amounts of Nutritious Forage That Is Relished by Animals

JAY B. PARK, Department of Farm Crops, Ohio State University

CLOVER has been called the cornerstone of American agriculture and the expression might well include European agriculture. It is stated on good authority that the domestication of clover has done more for Europe than the introduction of the potato.

This importance is due to the fact that clover, when inoculated with the proper bacteria adds to the soil the indispensable element nitrogen which is so expensive to buy in artificial manures. To be sure many other leguminous crops also secure nitrogen from the air but the outstanding importance of clover is due to the fact that it is easily grown on a variety of soils, lives more than one year and produces large amounts of highly nutritious forage which is relished by animals.

In recent years the alfalfa propaganda has occupied so much attention that we are likely to have a distorted notion of its relative importance in agriculture. Statistics on the acreage of clover in the United States are somewhat indefinite because of the fact that a large percentage of the clover grown is in a mixture with other forage crops, especially timothy. Yet it is a fairly safe estimate that the area devoted to red clover is approximately five times that devoted to alfalfa. Without much doubt, alfalfa is destined to become an important crop in the corn belt, especially for dairymen, but it never can replace red clover as the main leguminous crop in rotation systems.

The true clovers belong to the genus *Trifolium* which includes about 250 species, all of them confined to temperate regions. The nearest botanical relatives of the clovers are sweet clover

(*Melilotus*) and alfalfa (*Medicago*.)

Of more than 30 species of clover which have been tested experimentally in the United States, only six have become of importance: medium red clover, mammoth red clover, alsike clover, white clover, crimson clover and berseem.

Medium red clover (*Trifolium pratense*) is by far the most important of all leguminous crops and it is second only to timothy among forage crops in general. It is grown to some extent in every state of the Union, becoming less important in the southern states and reaching as far north as Alaska where it lives along the south coast but winter-kills in the interior.

Red clover is native in the greater part of Europe, in Algiers, in Asia Minor, Armenia, Turkestan and in southern Siberia. The date of its introduction to America is not known but it is mentioned by Jared Eliot as being grown in Massachusetts in 1747.

As it might be inferred from the wide distribution of red clover in the United States, it will grow on a considerable variety of soil types but succeeds best on rich, well drained, but moist soils in which limestone is abundant. Water-soaked soils are especially unfavorable. It does not thrive in the south because of the low fertility of the soil and the high temperature.

Red clover is usually treated in rotations as a biennial since the majority of the plants die after 2 years, although individual plants may live 6 or more years. Pastured plants, as a rule, live longer than those which are allowed to set seed. It is quite variable and includes numerous strains, some of which,

have been given regional names. Comparative tests of these strains under the same conditions have shown considerable differences in yielding capacity. Of the six species listed above, mammoth is the nearest like medium red clover and constant characters for distinguishing them are not easy to find. In general, however, they can be distinguished by the following characters. Mammoth clover is larger, blooms one or 2 weeks later, has solid stems and lives longer than 2 years. Medium red has hollow stems, produces both a hay crop and a seed crop the same season and usually lives but 2 years. Mammoth clover is preferable to medium red when only a hay crop is desired since it yields more. It also makes a better growth on poor or sandy soil.

The seeding of red clover may be done at almost any time which is convenient for the rotation. In the corn belt, it is usually sown in the spring with either fall or spring-sown grain. If sown early in the spring, before freezing and thawing are over, the honeycombing of the soil will cover the seeds. If sown later in the spring, it should be harrowed in or sown with the spring grain. Seeding clover with a nurse crop is the most common practice because of the economy of labor. Winter wheat or rye, and spring wheat, barley or oats are all used as nurse crops. Spring wheat is preferable to barley and barley is preferable to oats, because of the denser growth of oats with consequent shading of the clover.

Because of the hard, impervious seed coat of clover seed, it absorbs water with difficulty, hence the germination is usually slow and of low percentage. This necessitates a higher rate of seeding than would be required if all or nearly all the seed sown would grow at the desired time. Two methods have

been devised to overcome this difficulty. One of these consists in soaking the seeds in strong sulphuric acid for about 15 minutes and then quickly washing out the acid with a large volume of water. The acid attacks the hard seed coats without injuring the embryos and allows water to penetrate. It is necessary to add water quickly in large amounts in order to keep the seeds from being killed by the heat which develops. This method, if properly handled, increases the percentage of germination of the seed, but it seems to be better adapted to the treatment of small quantities of seed used in experimental work than to the treatment of large quantities. The other method consists in scratching or cracking the seed coats by throwing the seeds forcibly against a rough surface such as sand paper by means of an air blast. Machines, called scarifiers, for accomplishing this, are now on the market and are being used by many seed firms.

There are about 250,000 clover seeds to the pound and one pound evenly scattered over an acre would make about six seeds to a square foot. The usual rate of seeding is 6 to 8 pounds to an acre and some experiment stations recommend 10 to 15 pounds. The seed should be planted shallow, not deeper than one inch and usually one-eighth to three-fourth inches is better than deeper planting.

Red clover is admirably adapted for use in rotations. A few typical rotations are corn, oats, clover, in which wheat or barley may be used instead of oats; corn, oats, clover, wheat; and corn, soy beans, wheat, clover. The last rotation which includes two leguminous crops is especially desirable for soils deficient in nitrogen. In all cases the clover is sown with a nurse crop in the spring and allowed to grow the first summer without cutting. It goes thru

the winter, is cut for hay the next summer and if the second growth has a good setting of seed, it is cut with a buncher and threshed.

It should be born in mind that inoculated clover plants altho they obtain nitrogen from the supply in the air, do draw also upon the supply stored in the soil, and that returning only the roots and stubble of a clover crop, once in 3 or 4 years, will not maintain the supply of nitrogen in the soil. Analyses show that the roots and stubble contain about one-third of the total nitrogen of the plant. The whole plant must be plowed under or returned as manure, in order to enrich the soil materially.

Among many grain farmers of Illinois, it is becoming the practice to clip the first crop of clover in the early flowering stage, letting it remain on the ground. The second crop is then harvested for seed and the threshed straw returned to the field. The danger with this system is, that when seed fails to set, as sometimes happens, there is no revenue from the land. On the average, however, fairly good returns are secured and the increased yields of grain resulting from this treatment more than counterbalance the occasional loss of a seed crop. This practice is advisable only on farms which have not enough livestock to consume the hay.

According to the best information we have, red clover depends on insect pollination for the setting of seed, for when the heads are protected from insects little or no seed is formed. Both bumblebees and honey bees can accomplish cross pollination and a bumblebee has been observed to visit from 30 to 35 flowers a minute. Investigations have shown that clover is sterile to its own pollen which explains why crossing is necessary for seed production. This suggests the interesting possibility that self-fertile races of clover

may exist in our varieties or may arise in them.

Red clover does not thrive on soils which are acid, that is, soils which do not contain limestone particles. Probably the lack of sufficient limestone in soils with the resulting acidity is responsible for more clover failures than any other cause. Numerous experiment stations have shown the beneficial effect of limestone or burned lime on the growth of clover on acid soils. Application of some form of phosphorus in addition to the lime usually produces a further increase in yield.

The fungus diseases which are known to attack red clover are numerous, but few of them are a serious menace to its culture. Probably the most destructive disease is clover anthracnose which appears as purplish spots on the stem. No means of controlling this is known but results at the Tennessee Agricultural Experiment Station indicate that highly resistant strains of clover may be secured by selection.

The most serious insect pests are the clover root-borer, the clover-leaf weevil, the clover-flower midge and the clover-hay worm. In dry seasons grasshoppers sometimes cause considerable damage.

Another pest is clover dodder or love-vine. This is a slender, almost leafless yellow vine which lives parasitically upon the clover plants. It is propagated by small seeds which are difficult to separate from clover seed. These germinate in the spring. The young plants twine about the clover plants and sending in rootlets feed upon the sap. When this connection has been made, the dodder roots in the soil die and it lives entirely upon the clover plant. It spreads rather rapidly. When infested areas are found in a field, the plants should be cut close to the ground and burned.

CONTROLLING HELPFUL AND HARMFUL INSECTS

Work Requires Investigating of Their Relation to Man, Animals and Plants

L. O. HOWARD, Chief, Bureau of Entomology, United States Department of Agriculture

INVESTIGATING of beneficial and injurious insects in their relation to man and animals and to plant life is entrusted to the bureau of entomology. The bureau is divided into several branches, each having special lines of work. Some of these branches are given to investigating the insects that attack tropical fruits, Southern field crops, forest trees, fruit trees, truck crops and stored products, cereal and forage crops, and insects affecting the health of man and animals.

Controlling insect pests is not merely a matter of poisoning or cultivating or actual killing of insects. The investigator must first make a thoro study of the general agricultural practices of the crop affected. Perfection of control measures naturally rests upon such full knowledge of the life history and habits of the insects as can be obtained only thru exhaustive research.

Studying of entomology offers such a wide diversity of problems that it has a strong appeal for its devotees. Students hesitating between entomology and some other science can generally find an entomological problem which would enable them to associate two sciences. Such problems embrace medical, veterinary, chemical, physical, mathematical, botanical, agricultural, meteorological, economic, and systematic studies of wide diversity.

The field is constantly increasing and there is every year a demand for thoroughly trained men. The training should include as much language work as the student can conveniently take and should cover the elementary principles of the associated sciences in the branch of entomology selected by the student.

A survey of some of the problems of the bureau will probably convey an idea of the nature of preparation necessary and also the training afforded to those engaged in the work.

The cotton boll weevil is a little insect which destroys the buds and fruit of cotton and causes an annual loss in production of many millions of dollars. It entered the country from Mexico and has spread in 24 years as far east as central Georgia. This spread has been closely watched and mapped out year by year and is brought about by natural flight and by transportation. The study of methods of transportation demanded a study of the handling of the crop from the time it was pickled, thru its preliminary storage, its haul to the gin, the passage thru the gin, the disposal of the seed and lint on leaving the gin, the transportation of the baled cotton and seed by rail, the later hauling and use of cars which had carried these products, and the hauling of the seed at oil mills. These changes resulted in changing of ginning and oil mill machinery, methods of fumigating cars, and legal quarantines of shipments thru non-infested territory.

Two serious pests of forest and shade trees are the gypsy and brown tail moths imported from Europe. Problems involved in the handling of forest trees are different from those of a field crop and investigators found many obstacles in their way. They evolved chemical sprays to kill the worms and sticky bands to protect the trees. An effective organization of inspection was effected which makes each winter a search of all materials, including plants, lumber and even quarry products which

might carry any stage of the insects to uninfested regions. Explorers were sent to Europe and Asia in the search for parasites. The finding of favorable parasites necessitated the development of many ingenious methods of shipment of the parasites and rearing cages for their propagation, so that thousands could be released at a time.

Honey bees are beneficial insects contributing two valuable products, honey and wax. Investigators have worked to secure an improved breed which will produce more and better honey. They have studied the various plants that bees frequent and tested the characteristics of the honey from the various plants. Many bees die during the winter. It became necessary to determine the factors involved. So the entomologists have brought electricity to their aid and with the use of thermo-couples learned the temperature at all parts of the hive with relation to outdoor temperature and found under what temperatures the bees winter most successfully.

In the tobacco worm investigations a new form of arsenate of lead was developed which is more easily dusted on the plants and a better type of dust gun was invented to distribute the poison.

The Federal Horticultural Board confronted with the necessity of either refusing to admit foreign cotton to our market to prevent the advent of the dangerous pink boll worm, or finding some way of handling this cotton rapidly and cheaply, developed a vacuum process of cyanide fumigation whereby hundreds of bales of cotton can be fumigated each day.

Certain insects carry diseases of plants on their bodies or by passing the

organism thru their bodies. This is a field of work which is opening up and has great possibilities. Insects also have many diseases of their own and a few of these diseases can be controlled and utilized. On the other hand the silk worm and honey bee are ravaged with protozoal diseases which must be controlled. These various problems offer fields for research for the plant pathologist and insect borne diseases of man and the protozoologist.

Along the line of control of pests of man and animals the bureau has considerable work. In the Rocky Mountains the tick which carries the fatal spotted fever is being eradicated by dipping domestic animals, controlled pastures, trapping wild animal hosts, burning of pastures, and by several other means. In Louisiana the relation of malaria to the efficiency of labor and productivity of a plantation is being worked out, along with the control of mosquitoes and technical studies of mosquito transmission of malaria.

House flies involve problems in the control of the breeding of flies in manure and refuse. Methods efficient for farm purposes must be of such a nature as not to impair the value of the manure as a fertilizer. In this work an entomologist, a chemist and a bacteriologist may work together.

The various types of investigations are all obviously of an economic nature, but underlying all of these economic phases of entomology are many strictly technical studies of great importance. The morphological and systematic studies of the bureau are conducted by many persons, some of whom devote most of their time to the economic problems.



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COLUMBUS, OHIO, JANUARY, 1917.

EDITORIAL

FINDING OPPORTUNITIES.

Frequently young men are heard to say that they have not had an opportunity. It is strange to find this so when so many opportunities for improvement in farming and farm life as well as in other occupations present themselves. What is needed is more education given in the homes and the schools that will tend to develop the younger generation so that when they grow older, they will be able to see the things about the country that need to be done.

On the development of the rising generation depends the future of any country. Statistics show that the best of families in the large cities often degenerate with a few generations. To

replenish this population, the rural community is often called upon.

Too many country people encourage young folks to prepare for city life. Every citizen residing in his own community has some responsibility. One of these responsibilities is his duty to encourage the younger generation over whom he has direction to learn of the opportunities and to realize their responsibilities.

The rural districts of this country are still undeveloped when compared to those of some of the nations in the older world. To improve these rural conditions, many opportunities are offered to the efficient and energetic man who can see the things to be done. More educational work is needed

in training the younger generation, so that they will realize the responsibilities they have and see the things that need to be done in developing farming and farm life thruout the country.

THE NITROGEN PROBLEM.

It is becoming evident that to make a profit, larger yields must be obtained from every acre of land so that the same amount of work given to the care of crops will bring in a larger production to overcome the increased expenditure necessary for land and labor. When it is realized that in Europe the average yield of wheat is 32 bushels per acre while in the United States the average yield is but 15 bushels, it can be seen that an increase in yield is possible.

One of the factors affecting the yield is the supply of nitrogen in the soil. This may be added to the soil by either of two methods, one is by applying it in the commercial form as nitrate of soda or ammonium sulfate and the other is by growing of legumes in the rotation.

Because of the cost, the use of nitrate of soda is being questioned by many soil experts. Their way of solving the problem is by establishing a rotation which will have at least one crop out of four a legume and only adding the cheaper materials manure, lime and phosphorus as needed.

In following a rotation of corn, oats, wheat and clover, Hopkins of Illinois, found that where manure, lime and phosphorus were used a yield of 41 bushels of wheat was gotten when 22 bushels were gotten where none was used. These experiments tend to show that nitrogen can be supplied, partly at least, by crop rotations and the use of manure. As long as the high prices continue, the farmer will need to study his soil requirements and to use crop

waste, manure and crop rotation systems to maintain the nitrogen of his soil most economically.

FARM EXPERIENCE.

A requirement for the degree of Bachelor of Science in Agriculture given at Ohio State University should be at least one year of practical experience upon the farm. Many agricultural writers and thinkers in Ohio and other states are urging this and some Universities have already made this a requirement. Such a requirement would not only increase the efficiency and raise the standard of the College of Agriculture, but it would also prevent many students from wasting their time by starting on their course and afterward finding that agricultural work is not what they expected.

That such a requirement is for the best interest of the student was emphasized by Eugene Davenport, Dean of the College of Agriculture, University of Illinois, when he spoke recently in the chapel. He said that he advised the members of the sophomore class in agriculture who did not have a year of farm experience to stop at the end of the first semester and get such experience before they went on with their work. Giving as his reasons he said "A man who has never had such experience cannot enter into the farm work with the spirit of one who knows farm life, and whose hopes and ideals are centered upon the farm. The student from the city," he continued, "might not like farm life after trying it for one year and if this year of experience would show him this, it would be the means of guiding him into work for which he is suited and of keeping him out of work which he does not like."

On account of many students coming from the city, it makes it necessary to

teach many things with which students from the farm are already familiar. This not only means a waste of time for the teacher and the student coming from the farm but it also means that the interest of those students will be lost to a large extent because of being required to do much routine work that is familiar to them. If the interest of the student is to be held they must be given something new so that they will look forward to its development.

Managers and superintendents in the factories and teachers in the business colleges are chosen from men who have had practical experience in the work they are directing. If such work, which does not require as broad a knowledge and the ability to adapt oneself quickly to changing conditions requires such men, is it not ridiculous to think that farm managers and teachers can be chosen from men who have had no previous farm experience?

Much is expected and likewise much should be expected of a graduate from the College of Agriculture. If he is not able to farm successfully, it reflects back upon the college with the result that farmers lose faith in agricultural teaching. The teachers in our agricultural colleges must come from these graduates. Can anyone, who has never lived on the farm, whose sympathies cannot be with the farmer, be an ideal teacher for the farmers' children?

No doubt if a year of farm experience is required, the attendance in the agricultural college would decrease. This is usually the case whenever the standard of anything is raised as fewer people are able to qualify. On the other hand when a standard of any enterprise is raised, more faith is placed in it with the result that a later reaction takes place and more try to

reach the high plane that has been set. By placing agricultural teaching on a higher plane, adding farm experience to the requirements for a Bachelor of Science degree in Agriculture would be for the best interests of the students, the teachers and the College of Agriculture.

LIME NEEDED FOR GOOD CROPS.

That practically every farm crop must have lime for either of three purposes is known practically to every one. It must be used to keep the soil sweet, to make the plant food in the soil available and as a food by some plants.

Some soils already contain so much lime that it is not worth while to add more. How much lime should be applied or whether it should be used at all depends on how sour the soil is or how deficient it already is in lime. In various states experiment stations are usually glad to receive samples of soil, test them for lime and advise as to the treatment needed.

Even limestone soils may need lime after they have been farmed for some time. This is especially true where there is abundant rainfall. If the land has been cultivated for a long time and clover and alfalfa do not do as well as they formerly did, it would be well to test the soil with litmus or any other way to see whether the soil is becoming acid. By making the conditions in the soil right for the growth of crops, the farmer will not only raise better crops but he will also make a greater profit.

ACKNOWLEDGMENTS.

For suggestions in preparing the material for this issue we are indebted to Professor Firman E. Bear of the department of soils and for photographs to Professor Gardner of the Pennsylvania State College.

Home Economics Department

EXPENSES OF A HOME ECONOMICS STUDENT AT OHIO STATE UNIVERSITY

E. JOSEPHINE JONES, '17

THE cost of attending the University for a year differs with almost every girl. A girl who boards herself and saves in every possible manner may get thru the year on a mere pittance while the girl who drives her own electric may spend several thousand dollars. Since the University is located in a city rather than a small town, there is great temptation to spend money. There are concerts and good plays at the theatres and grand operas, all of which are cultural but costly; however, the student who wishes to secure an all-round education and development should include some of these entertainments in her expense account.

Altho there is a great difference between the smallest and largest budgets of Ohio State University girls, it is probable that most would fall within the limits of \$250 and \$800 per year. One girl by careful planning, buys all her clothing, pays all her school expenses and lives comfortably on \$280 a year. Perhaps an average would be about \$350 and would be divided as follows:

Tuition	\$30.00
Laboratory fees.....	15.00
Books	15.00
Incidental school expenses.....	10.00
Board and room.....	190.00
Clothing	70.00
Miscellaneous Expenses.....	20.00

This budget, of course, is only approximate. A girl may be living at home or with relatives and will not have to pay board and room rent. Again she may not include her clothing

and other expenses in her school account.

There are many ways by which girls may lower their expenses and earn part or all of their way thru college. The Dean of Women is in charge of the Women's Employment Bureau of the University and she aids in finding places to work for girls who are desirous of helping themselves thru school. Many girls stay with children during the evenings when the parents are away. Others help with the house and kitchen work to pay for their board and room. Some go into peoples homes and prepare the evening meal and wash the dishes for a small sum. One girl who lives on a farm near Columbus has put herself thru school by raising poultry. Many girls do stenographic work and others clerk in downtown stores on Saturdays.

In this day of coeducation and student loan funds, a girl who is alert and determined may secure a college education entirely by her own efforts.

SALADS.

The food value of green salads is not high but the salts they supply make them of great value as a food. Salads are cooling, refreshing and assist in stimulating the appetite while the oils or butter that are usually found in the dressings furnish nutriment.

To arrange a salad gives the cook more chance to display her artistic ability than probably any other way that food may be prepared. An artis-

tically arranged salad helps in making the rest of the meal palatable.

The salad must be cold and attractively garnished, the greens in it crisp and the ingredients in the dressing carefully proportioned and well blended.

Lettuce is used as a bed for any salad. As soon as it comes into the house it should be sprinkled and placed in the ice box or wrapped with a damp cloth and kept as cold as possible. To prepare it for use, the stem should be cut off, the leaves separated and allowed to lie for at least 15 minutes in the coldest water available. The leaves should be washed clean, care being taken not to break them and to see that no insects cling to them. Then the leaves should be wiped carefully with a soft cloth for if they are left wet the dressing will run off of them.

Scraps of food can be worked up into a salad when almost no other use can be made of them. Remnants of cooked vegetables may be put into a colander and hot water poured over them to rinse off any butter or dressing. By using originality and invention the

cook will be able to produce many salads from left over food products that have never been described in the cook book which are delightful both to the eye and taste. Some people have salad instead of dessert and if one cannot have both at the same dinner, it is well to substitute salad for puddings or pies two or three times a week at least.

MAYONNAISE SALAD DRESSING.

Mayonnaise salad dressing is made by mixing together one egg-yolk, one tablespoon of lemon juice, one tablespoon of vinegar, three-fourths cup of olive oil, one-half teaspoon of sugar, one-half teaspoon of salt, a few grains of paprika and if desired one-half teaspoon of mustard.

Mix the dry ingredients in a cup and add the vinegar and lemon juice. Add one-half of this mixture to the egg yolk and beat thoroly. Add the oil by teaspoonfuls beating after each addition until about six have been added. It may then be added more rapidly. If for any reason the mixture separates add this slowly to another egg just as the oil alone was used in starting the dressing.

J. C. Hedge, '10, who was recently appointed county agricultural agent in Summit County, is holding several dairy meetings and is assisting with the Farmers' Institutes in that county.

Robert Wylie, '15, and Gladys M. Stilwell of Columbus, were married at her home on December 21. They will make their home at Ames, Iowa, where Wylie is instructor in dairying at the Iowa State Agricultural College. When in school, Wylie was a member of the dairy cattle judging team which took

first honors at the National Dairy Show at Chicago in 1914. He also assisted in the department of dairying during his senior year.

Frederick N. Winkler, '14, and Virginia V. Pringle were married on December 16. They will make their home at University Place, Columbus, after January 15. Winkler is engaged in the life insurance business.

C. E. Wylie, '15, is instructor in dairying at the Tennessee Agricultural College located at Knoxville.

Secondary Agriculture

COOPERATION OF THE COUNTY AGENT AND SCHOOL

D. R. VANATTA, County Agent, Hamilton County

A COUNTY AGENT should be to the agricultural interests of a county what the superintendent of schools is to the educational interests. In most cases he is a practical as well as an educated farmer who thru his personal work with the farmers of his county is able to introduce methods which have elsewhere proven successful into the county.

The county agent as a representative of both the farmer and the educator should be in touch with and cooperate with them in the application of the more successful methods of agriculture. The school house as a community center, with the teacher conducting welfare associations, forms an excellent opportunity for the county agent to come in touch with the people. Here it is possible to secure the interest of the school children if not the interest of the parents. Where the child's interest and good will is secured, the good will of the parent is usually certain to follow.

Agricultural education is now accepted both inside and outside of institutions of learning. All agree that agriculture should be added as another course of study in both city and country schools. There are children in the schools, who are not suited to shop work and are also failures in arithmetic, geography, and the languages, but who have a love for living things. These are the children that agriculture will benefit most.

To properly instruct the children, it is necessary for the teacher to make a study of agriculture tho he can not spe-

cialize in it nor even be intimately acquainted with it in all its phases. He can only have a general knowledge of the subject and for the details, good use could be made of the county agent. If the district superintendent knows the plan of work the county agent has outlined for that community for a year, he can aid in the work by having the teachers emphasize the main topics in agriculture as they are taken up in the general scheme. This method of cooperation with the county agent would work to build up the child's interest along the same lines in agriculture. In this way the interest would be greater and there would not be any division of purpose, as is often the case.

Club work, conducted by the cooperation of the county agent and the county superintendent of schools, is one of the best ways for both the county agent and the schools to secure the unfailing interest of the children and the parents. The good which comes from working together in a club or group can not be measured at the present time, for this work will teach the children to cooperate all thru life. It makes for better citizenship and better men and women.

Team work which counts in all of life's enterprises, holds true in the county agent's work with the school boys and girls in club work. Broadly speaking the aim of the county agent and the aim of the public schools is to interest the younger generation in the work of their home community.

A study of the type of farming fol-

lowed by the farmers should be made and the boys and girls encouraged to attempt improvement upon the methods of their fathers. It should be firmly impressed upon them that this work is worth while and as important as any other occupation and that the dignity and welfare of the nation is as much at stake in the successful growing of abundant crops on the home farm as the successful output of any manufacturing plant.

A broad education gives capacity for enjoyment of life and makes stronger men and women who are less suspicious of their fellow men and freer from superstition and religious fallacies. They are easier to get along with. They have learned to cooperate and while the school courses could be more practical, at the same time, we need to think less of an education as a means of making a living and more of it as a means to a larger enjoyment of life.



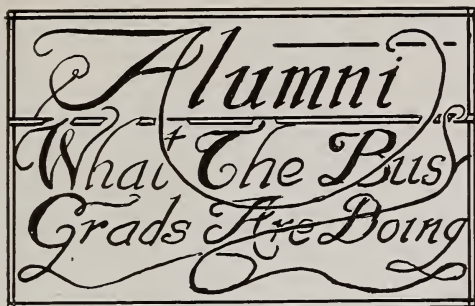
County Agent and Specialist Holding a Pruning and Spraying Demonstration With School Children

Stanley B. Stowe, '10, agricultural agent in Clermont County, has been instrumental in perfecting the organization of the Clermont County Farm Bureau. The first annual meeting was held on November 25 at which time it was decided to continue the work of the agricultural agent.

D. R. Van Atta, '10, agricultural agent in Hamilton County reports enthusiasm regarding the work of the agricultural engineering and poultry specialists in the county held recently. Several tile drainage systems were laid out and help was given in the planning

of farm buildings. Virgil Overholt, '15, specialist in agricultural engineering, assisted in the work and M. C. Kilpatrick, specialist in poultry husbandry, visited several poultry farms and addressed a number of poultry meetings in the county.

W. W. Brownfield, '12, newly appointed agricultural agent in Washington County, began work on December 1. He spent the first of the month with the retiring agent E. J. Riggs in getting acquainted with the farmers of the county and with their agricultural problems.



Donald R. Acklin, '08, is engaged in livestock farming at Perrysburg, Ohio. He is a member of the State Board of Agriculture and is also employed by the Toledo Commercial Club to further the agricultural interests of Lucas County.

Joseph F. Barker, '08, is agronomist at the New York Agricultural Experiment Station at Geneva. In addition to having under way at Geneva quite a number of experimental projects he is also carrying on experimental work at a number of sub-stations in various places over the state.

M. H. Bartter, '08, is county agent in Geauga County. Previous to going into county agent work, he managed the home farm near Columbia Station, Ohio.

Firman E. Bear, '08, is engaged in instructional work in soils at the Ohio State University.

R. C. Collison, '08, is assistant agronomist at the New York Agricultural Experiment Station at Geneva.

B. E. Collison, '08, is head of the department of agricultural chemistry at the Florida Agricultural College at Gainesville. He has been carrying on work on "The use of fertilizers on citrus fruits grown on the sandy soils of Florida."

J. L. Edmonds, '08, is professor of animal husbandry at the University of Illinois. He is in charge of the horse breeding experiments at that place. He

also contributes frequently to "The Breeders' Gazette."

Scott C. Hartman, '08, is farming at North Fairfield, Ohio. He has been breeding Berkshire hogs.

C. W. Hengst, '08, is farming near Lancaster, Fairfield County, Ohio.

J. W. Wuichet, '08, is engaged in agricultural extension work at Ohio State University. He was formerly interested in the breeding of Hampshire hogs on his farm near Dayton, Ohio.

O. M. Johnson, '08, is state leader of county agents in Ohio. He was formerly professor of farm management at the University of West Virginia.

Edmund Kinney, '08, is assistant agronomist at the Kentucky Agricultural Experiment Station.

Burt Miskimen, '08, is engaged in sheep farming in Tuscarawas County, Ohio.

Albert R. Moist, '08, is managing a large plantation in Louisiana.

Louis D. Risser, '08, is farming near Columbus Grove, Ohio. He and his brother own a sales barn in Columbus Grove, where they buy and sell horses. They have been engaged for some time in fattening horses for the eastern markets.

Roland W. Rodgers, '08, is a farmer near Cincinnati. Mr. Rodgers has been successful in developing a fruit farm.

Philip L. Rothrock, '08, is employed in the bureau of grain standardization, United States Department of Agriculture.

Ivan Steiner, '08, has lately moved to the home farm near Orrville, Ohio. He was formerly employed in running a large dairy farm near Ossining-on-the-Hudson.

Henry W. Vaughan, '08, is associate professor of animal husbandry at the Iowa State Agricultural College, located at Ames. A contribution of his is a

book entitled "Types and Market Classes of Live Stock."

John O. Williams, '08, is teaching in the department of animal husbandry at the North Carolina Agricultural and Mechanical College. He was formerly breeding horses in Colorado for the United States Department of Agriculture.

R. E. Wright, '08, is engaged in research work in soil bacteriology with Doctor Kellerman of the United States Department of Agriculture, Bureau of Plant Industry, Washington, D. C.

M. Edward Corotis, '08, is engaged in the real estate business in Columbus.

Joseph H. Gourley, '08, is professor of horticulture in the New Hampshire Agriculture College at Durham. He has also been carrying on research work at the New Hampshire Agricultural Experiment Station, which is located at the same place.

Ira G. McBeth, '08, who has been a member of the division of soil bacteriology of the United States Department of Agriculture received the degree of Doctor of Philosophy from the University of California in June, 1916. His thesis work consisted of a study of the organisms which decompose cellulose in soils.

J. E. Clawson, '08, is farming near Okeana, Ohio.

R. W. Cory, '08, is running a general farm near Frankfort, Ohio.

J. H. Cox, '08, is employed in the United States Department of Agriculture at Baltimore, Maryland.

David P. Snodgrass, '08, is following livestock farming near Cannonsburg, Pennsylvania.

James C. White, '05, is farming near Delaware, Ohio.

Paul W. Barnes, '11, is horticulturist for the Glennview Fruit Co. at Linn-dale, Ohio.

Frederick W. Taylor, '00, is dean of the College of Agriculture at Durham, N. H.

George B. Merrell, '08, is farming at St. Petersburg, Florida.

Benjamin L. Thompson, '08, is teaching animal husbandry at the South Dakota Agricultural College.

Clarence S. Woodard, '08, is teaching in the Tuskegee Institute at Tuskegee, Alabama.

E. O. Fippin, '00, is professor of soils at Cornell University, Ithaca, New York. He assisted in writing a book entitled, "Soils, Their Properties and Management."

C. R. George, '12, is in extension work in Indiana with headquarters at Purdue University at Lafayette. He is secretary of the Indiana Dairymen's Association. He formerly taught in the Agricultural College at Berkeley, California.

F. N. Fagan, '10, is teaching at the Pennsylvania State Agricultural College. He attended the apple show recently held at the Ohio State University with the judging team representing that institution.

Willis C. Lane, '15, has left the University of Maine and has gone to Colorado for the winter because of poor health.

Sleeter Bull, '10, is associate in animal nutrition in the College of Agriculture and Agricultural Experiment Station of the University of Illinois. He has recently written a book entitled, "The Principles of Feeding Farm Animals."

G. D. Norton, '14, has recently purchased a 104 acre farm near Lodi, Ohio. He is developing a herd of pure bred Jersey cattle. He began his herd by purchasing two registered heifers from high producing dams.

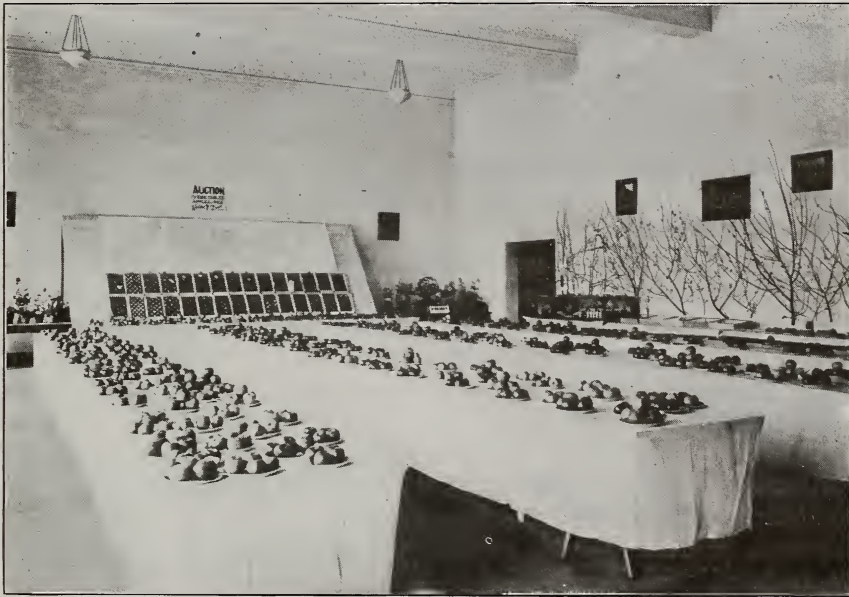
JANUARY NEWS NOTES

APPLE SHOW.

Showing the results of good care and selection was the expression of the judges in speaking of the exhibits at the Sixth Annual Apple Show held in the Horticulture and Forestry Building, December 14 to 16. Besides the displays of apples and vegetables, several special attractions were included among which were the Inter-State Students' Apple Judging Contest, the stu-

previously been won once by teams from New Jersey and Ohio State. New Jersey ranked second with 3820 points, Pennsylvania third with 3813, Ohio fourth with 3791 and Kentucky fifth with 3685 points.

In individual scoring, Harry Holcombe of New Jersey, and G. E. House of West Virginia, tied for first place with 3926 points. R. G. Test of New Jersey, took third with 3900 points and



Exhibits at the Sixth Annual Apple Show

dents' judging contest and displays by different organizations in the College of Agriculture.

By scoring a total of 3847 points out of a possible total of 4000 the team from the University of West Virginia won first place in the Inter-State Judging contest which was participated in by teams from New Jersey, Pennsylvania, Kentucky, Ohio State and West Virginia. It takes the cup valued at \$125 donated by the West Virginia Horticultural Society and which has

W. C. Koons of Pennsylvania, and Clay B. Eddy of Ohio State, were tied for fourth with 3860 points each. Eddy of Ohio State, made a perfect score in identification of varieties. Clay B. Eddy, Thomas L. White and Alvin W. Barr composed the Ohio State team.

Exhibiting 60 varieties in a table display and winning in a majority of them, Clarence M. Ochs, senior, won the sweepstakes prizes in both the classes open to student and commercial growers of apples. He takes the cup donat-

ed by President Thompson to the student exhibitor having the best display besides many other prizes. Howard Scarff, senior, had the second best exhibit and Isaac P. Lewis, senior, stood third. In the vegetable exhibits, Howard J. Ruetenik, sophomore, took the sweepstakes in the classes open to student growers while Vick Brothers of South Columbus, won in the commercial growers' classes.

Isaac P. Lewis, senior, by winning first place in the students' apple judging contest will have his name engraved on the cup of the Ohio State University Horticultural Society. Ralph R. Rothacker, junior, took second place in the contest and Clarence M. Ochs, senior, third place.

Among the displays were those of the Forestry Society and the landscape architecture department. The Forestry Society presented a model illustrating the effect of denudation of forest reserves on erosion. Samples of all the commercial woods of Ohio were also shown and demonstrations of the tools used in forestry work were given by the students.

An attraction in the landscape architecture display was the model of a typical Japanese garden. In this model all the features were constructed to scale including the miniature gold-fish in the pond in the center of the garden, the house and the statue of Buddha.

Paul Thayer of the Ohio Agricultural Experiment Station, was judge. All fruit and vegetables were sold at auction, Colonel D. L. Perry of Clintonville, acting as auctioneer.

FIFTH ANNUAL FARMERS' WEEK.

With 100 speakers on the program, agricultural information from every angle will be on tap at the fifth annual Farmers' Week to be held at the Uni-

versity, January 29 to February 2. Included in the list are farmers, federal investigators of national agricultural problems, agricultural editors, teachers, directors of agricultural experiment stations and extension work, heads of agricultural colleges and officers of various agricultural organizations.

Prominent among the speakers will be Herbert Quick, member of the Federal Farm Loan Board and a former editor of the Farm and Fireside; Isabel Bevier, head of the department of household science at the University of Illinois; Moses Breeze and Ralph Felton, of the board of home missions of the Presbyterian church; W. H. Card, poultryman from Connecticut; H. W. Collingwood, president and editor of the Rural New Yorker; Hon. Henry M. Dunlap, Orchardist and president of the National Apple Growers' Association, E. C. Eikenberry, president of the National Grain Dealers' Association; Julius Kahn, secretary of the National Dairy Council; J. G. Lipman, head of the New Jersey College of Agriculture and Experiment Station; Virginia Meredith, president of the Indiana Home Economics Association; Rose Morgan, soloist, New York City; and C. E. Thorne, director of the Ohio Agriculture Experiment Station. A large number of the faculty of the College of Agriculture including President W. O. Thompson, Dean Alfred Vivian and Clark S. Wheeler, director of agricultural extension, will also be on the list.

Dates announced for the different meetings are: Ohio State Corn Show, January 29 to February 2; Ohio State Dairyman's Association, January 30 to 31; Ohio State Vegetables Growers' Association, February 1; Egg Show, January 30 to February 2; Ohio Rural Life Association, January 30 to February 1; Ohio Percheron Breeders' Asso-

ciation, January 31; Ayrshire Breeders' Association, January 31; Ohio Guernsey Breeders' Association, January 31; State Boys' Stock Judging Contest, January 29 to February 2; Ohio Jersey Cattle Club and Holstein Breeders' Association, February 1; Ohio Hereford Breeders' Association, January 31; Former Students' Reunion dinner, January 31 at noon; State Farmers' Institute workers meeting, January 30.

The illustrated lectures, "A Trip Around the World" will be given again this year by Dean Alfred Vivian. They will be given in a series of five at 4 o'clock each afternoon of Farmers' Week in the chapel. The evening lectures will also be given in the chapel.

AGENTS PROBLEMS DISCUSSED.

O. M. Johnson, county agent leader of Ohio, who attended the annual conference of county leaders, held recently at Washington, gives the following as the consensus of opinion of the leaders on several of the topics discussed. In order for county agent work to make best progress in a county there must be a good understanding of the work. A campaign of education conducted by means of press articles, public addresses, circulars and other agencies should be carried on before the county agent begins work. This will offer an accurate idea of what the county agent expects to do, what he cannot do and how the work should be organized to make possible the greatest success.

The most successful way of raising the farm bureau's share of the funds for county agent work is by means of an appropriation, obtained thru the county commissioners rather than by attempting to raise money thru membership dues or by popular subscription.

A well-organized and active county farm bureau association is highly im-

portant to the success of agricultural agent work in a county. Committees on different divisions of the work should assume certain responsibility and cooperate with the agent wherever possible. The ability of an agent to secure cooperation of members and of committees of the farm bureau association is an indication of efficient work.

It is important that the men on whose farms demonstrations are conducted should have influence in the community. No matter how satisfactory the results of the demonstration may be, it is likely to prove of little service to the community if the man is disliked on whose farm the demonstration is conducted. The best farmers of the community are frequently conservative regarding all new movements and are not always the most forward in seeking demonstrations and in becoming immediately interested in county work.

Demonstration work in a county should be planned to extend over a period of years. The farm bureau association should carefully diagnose the agricultural problems of the county and formulate a definite policy thru the selection of projects. The policy should be maintained regardless of changes in county agents or officers, unless new conditions make modifications necessary.

The demonstration of a fact is not enough. It should be persistently followed up at opportune times by meetings, press articles, circular letters and any other means available.

When starting a project such, for instance, as a farm management demonstration, the work should first be carefully explained. Records should be obtained only from interested farmers. Account books for such demonstrations should be of forms approved and furnished by the agricultural col-

lege extension service. The aim should be to encourage the farmer to keep his own records in simple form, with the idea that he will analyze his business thru their use.

HOLD EXTENSION SCHOOLS.

Forty communities are holding one-week extension schools in agriculture and home economics this year. The first school began on December 4. The season will close March 9.

Separate sessions are held for men and women. Instruction in soil fertility and farm crops are given at all sessions for men in addition to a series of lectures and demonstrations in dairying, horticulture and animal husbandry. A specialist also provides 2 hours of instruction in either agricultural engineering or poultry husbandry.

The section for women is devoted to lectures and demonstrations on various phases of home economics. With the exception of local expenses, the cost of the schools is paid from funds of the Ohio State University College of Agriculture provided by the Smith-Lever Act.

PAID TO STUDY HIS BUSINESS.

Studying the analysis of his farm profited one Ohio farmer at least \$1500 the first year and the profits are still increasing.

An analysis made by G. N. Dagger of the agricultural extension service showed that the milk receipts per cow on this man's farm were \$89 and the livestock receipts for each \$100 worth of feed used were \$76. Figures of this sort had never been presented to him before. He began to study and it took little effort for him to see that he was keeping some unprofitable cows. The next year he kept the size of his business the same, fed the same amount of

feed as the year before and bought the same amount. By eliminating the unprofitable cows, however, he succeeded in increasing the livestock receipts per cow from \$89 to \$180 and the livestock receipts per \$100 worth of feed from \$76 to \$176. This made it possible for him to increase the profits from his farm \$1,500, in addition to receiving what the farm contributed toward the living and after deducting 5 percent interest on the investment.

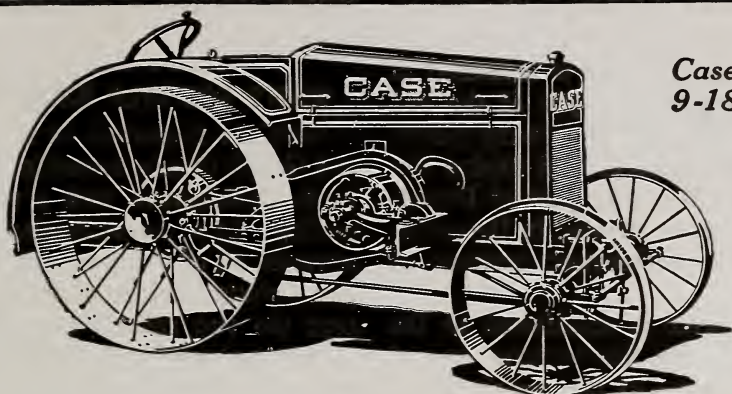
COW TESTING ASSOCIATIONS.

Two new cow testing associations were organized recently, one near Claridon and Munson in Geauga County and the other near Warren in Trumbull County. The Munson Claridon Association is the first to be started in Geauga County while the Warren Association is the fourth in Trumbull County. Both started on December 1.

Roger D. Long, newly appointed agricultural agent in Cuyahoga County began work December 1. Long comes from Rockingham County, New Hampshire, where he was the agricultural agent.

PLANNING SEASON'S PROJECTS.

Specialists of the Extension Service spent much time during November and the early part of December in writing projects with the different county agricultural agents. Preliminary reports indicate that several new demonstrations will be introduced, while on the other hand, a large number will be continued. Unless there is some especially good reason for changing the established program of demonstrations in the counties, the agents are being encouraged to follow the projects which they have undertaken. It is expected that all the agreements will be signed by January 1.



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INSTITUTES POPULAR AS EVER.

Increased attendance at farmers' institutes over last year is indicated in the early reports, in spite of the bad weather that prevailed at many places. Most of the meetings held during November and the early part of December are at points situated in the southeastern and northeastern sections of the state.

Good interest is manifested in the rural community life lectures, one of the new features of this year's activities. Fifteen speakers are devoting their efforts to this portion of the work.

As usual, the institutes will progress across the state during the season in the

general direction of southeast to northwest.

MANY SCHOOLS BEAUTIFIED.

With the inspection of the Pleasant and Grand Prairie township schools by R. B. Cruickshank with a view to directing the beautification of the grounds, all of the rural schools in Marion County have been visited. All except the two schools mentioned have executed plans for planting which have been furnished by the Extension Service. The work has been done in cooperation with M. C. Thomas the county agricultural agent, and the county superintendent of schools.



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Reception Night Thursday evenings.

Reception Night Saturday evening (front hall).

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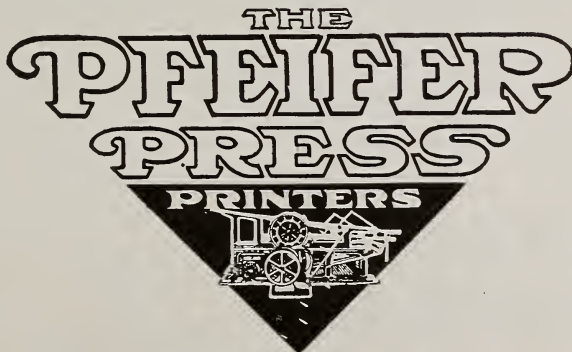
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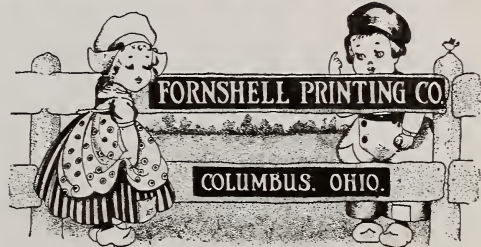
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*The one place around
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can get good things to
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**The Feed
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Cotton Seed Meal

Get Our Prices Before You Buy.

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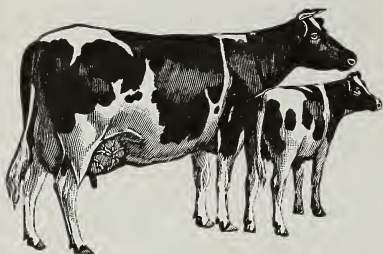
Established 1901—A reputation of 15 years for square dealings.

No Better Clothes than Mendel's at Any Price

Suits Made and Guaranteed to Fit, From \$18 to \$40.

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Purebred Registered HOLSTEIN CATTLE

During the fiscal year ending April 30, 1916, there were reported to the Advanced Registry Office of the Holstein-Friesian Association, 11,868 short time official records, over one-half of which were by heifers with first or second calves. The average seven-day production of these 11,868 animals was 401.1 lbs. of milk, containing 3.53 per cent of butterfat. These figures emphasize the fact that Holstein merit is based, not on individual records, but upon the wonderful uniformity of high productiveness of the purebred Holstein cow. There is big money in the big "Black and White" Holsteins.

Send for FREE Illustrated Descriptive Booklets.

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THE VILLAGE FARM offers
a solid colored Bull, dropt
Jan. 25, 1915. Dam, Melia's
Nervilette 224,435, produced 72
lbs. 2 oz. in 30 days. Tuberculin
tested. Ready for shipment.
Price \$100.

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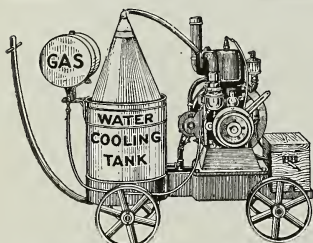
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Made from APOLLO-KEYSTONE
Copper Steel Galvanized Sheets,
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sheets manufactured.

These sheets are unequalled for Silos,
Culverts, Tanks, Roofing, Siding and all forms of ex-
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to brand. Send for our "Better Buildings" booklet.

AMERICAN SHEET AND TIN PLATE CO., Pittsburgh, Pa.



4 H. P.—190 lbs. Hand Truck Outfit, Easy
to Pull Around From Job to Job. Same
Engine Used on Binder.

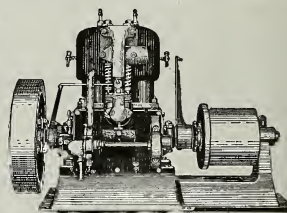
The 4 H. P. Cushman Handy Truck
is the most useful outfit ever built
for farm work. Engine weighs only
190 lbs., and entire outfit only 375 lbs.

Besides doing all farm and house-
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be lifted from truck and hung on
rear of binder during harvest to
save a team. In wet weather it
saves the crop.

LIGHT Weight **CUSHMAN ENGINES**

Built for farmers who need an en-
gine to do many jobs in many places
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Throttled Governed, with Schebler Carburetor. Runs very quietly
and steadily—not with violent explosions and fast and slow
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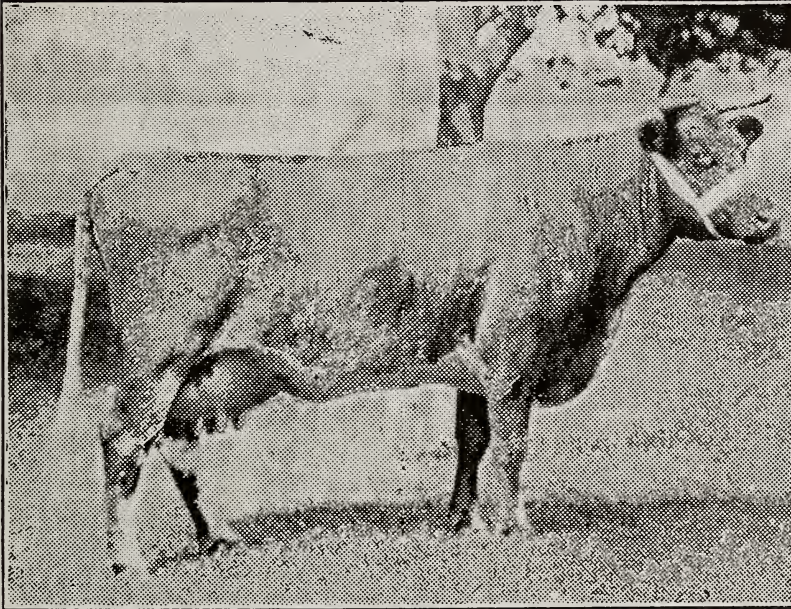


8 H. P.—320 lbs. Two Cylinder
Friction Clutch Pulley.

CUSHMAN MOTOR WORKS, 926 N. 21st St., Lincoln, Nebraska

The Otis Herd of MILKING SHORTHORNS

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OUR HERD
Comprises
150 Hd.
of
DUAL
PURPOSE
SHORT HORNS,



GOOD
YOUNG BULLS
and
A Few Females
For Sale.



Write for
New Catalogue.

Weight 1,600 lbs.

IMP. BRITISH ROSE

Record 10,000 lbs. a year.

MERIDEL FARM DUROCS

THE POPULAR KIND

It took good sows and good boars to produce them. They came from ancestors of the **big type**. Those smooth quick feeders with strength, big bone and good action. Capable of doing their own harvesting for a large part of food from blue grass, clover and alfalfa pastures.

Always Glad to See You.

MERIDEL FARM, BLACK LICK, OHIO

On East Broad Street Nine and One-Half Miles East of Columbus, Ohio.

Where Good Sows and Good Boars Meet.

Maple Avenue Stock Farm

THE HOME OF THE CHAMPIONS

HERD SIRES

Johanna Concordia Champion, No. 60575; Duke Ormsby Pietertje De Kol 3d, No. 107737, and "The Milk & Butter Champion," No. 158089, the only bull in the world with a world's record milk producing dam and whose sire's dam is a world's record butter cow.

Cows and heifers bred to these great bulls, bulls and bull calves always for sale.

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Settle the Silo Question

—and settle it for good. Do away with repairs, with tightening of lugs and adjusting of hoops. *Know* that your silo won't blow over. Be sure of perfect silage at all times. Build the worryless, efficient



A Natco Silo and a Natco Barn mean Permanency and Prosperity.

Natco Everlasting Silo "The Silo that Lasts for Generations"

Its hollow, vitrified, clay tile are impervious to air and moisture—they preserve the silage *sweet and juicy*. The dead air spaces in the wall resist frost—making it the silo for severe climates. The continuous, reinforcing bands laid in the mortar hold it in a grasp of steel. It is a silo of *efficiency*, and a silo you'll be proud of. Send for our silo catalog describing it fully.

Also get our splendid new book, "Natco On The Farm," describing other farm buildings made of Natco Hollow

Tile and just as efficient. Both books free. We have many farm building plans to submit, and

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23 Factories—Prompt Shipments.



Natco Silo Wall.
Notice steel reinforcing bars laid in the channel.

Choice Pure Bred Live Stock

is bred by the Animal Husbandry Department of the

Ohio State University

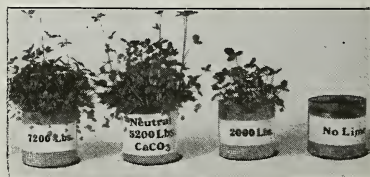
We breed Percherons, Clydesdales, Hackneys, Shorthorns, Jerseys, Holstein-Friesians, Guernseys, Shropshires, Merinos, Berkshires, Duroc-Jerseys, Large Yorkshires and some others. We often have surplus stock for sale at a reasonable prices.

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AGRICULTURAL LIMESTONE

Order early on account of car shortage.



Write today for the best free booklet published telling how Marbelime sweetens the soil and increases production.

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World Needs More Food

You can produce more by making better seed beds.

Get a disk harrow with these improved practical features: cutlery steel disks, forged sharp; hardwood bearings, oil-soaked and dust-proof; split-lock bolts that cannot rattle loose. Select a

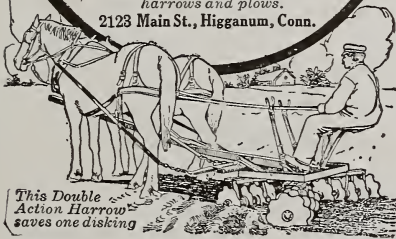
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The Double Action has rigid main frame, extra strong, that doubles efficiency. 100 styles to choose from—Single, Double and Special Purpose Types. Ask your dealer for the genuine CUTAWAY. Our book, "The Soil and Its Tilage," tells how to increase yield—a card brings it to you—FREE.

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Maker of the original CLARK disk harrows and plows.

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Waist High Alfalfa Instead of Knee High Because He Used Ground Limestone



When E. Z. Hitt, of Altenburg, Mo., bought his LIMEPULVER he made generous applications of pulverized limestone. He writes: "Never before the application of pulverized limestone could we grow alfalfa higher than knee high, but since the application my first cutting was waist high and higher."

The Jeffrey LIME PULVER

Enables any farmer to grind limestone right on the farm at the rate of from 1 to 7 tons per hour. Rock can be fed weighing 60 lbs. or more, and instantly reduced to dust, or crushed for road and concrete work. Portable—Every machine guaranteed. Write for trial offer.

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—FOR— Cheese Making on the Farm USE CHR. HANSEN'S Rennet Tablets AND Cheese Color Tablets

Also Try Our

Danish Butter Color

It gives that beautiful golden June shade and does not affect, in the least degree, the aroma or flavor of the butter.

CHR. HANSEN'S Rennet Extract, Cheese Color, and Lactic Ferment Culture have stood the test of time.

CHR. HANSEN'S LABORATORY

Box 1212, LITTLE FALLS, N. Y.

DEWY'S READY RATION

Guaranteed Analysis

25% Protein, 6% Fat, 10% Fibre

COMPOSITION:

Eagle Distillers Dried Wheat Bran & Middlings
Grains Pure Hominy Feed
Choice Cotton Seed Meal Malt Sprouts
Linseed Oil Meal ½% Salt

Dewey's Ready Ration produces large milk flow. Dairy cows eat it greedily. Keeps them in good flesh—the pink of condition. Feed Dewey's Ready Ration and get

MORE MILK

better milk—at less cost. Feed it with home-grown hay, straw, fodder, ensilage, roots. Forms perfectly balanced ration. No other grain or feed necessary.

Scientifically blended from highest grade feeds to produce most milk at smallest cost. Bulky and palatable. Easily digested and assimilated. Contains nutrients that make milk. Increases dairy profits. ABSOLUTELY GUARANTEED. Ask your dealer or write us for sample and information. Mention your dealer's name.

THE DEWEY BROS. CO.

Box 577

Blanchester, Ohio

DISTILLERS' DRIED GRAINS

The only high protein concentrate that is safe to feed in any quantity for any time. Contains about 80 lb. digestible matter per cwt. Fine for cows, steers and sheep. Did you know that in every Exp. Sta. Test where D. D. Grains were compared with C. S. Meal and Oil Meal in feeding steers D. D. Grains have always produced the most economical gains. The D. B. Co., Blanchester, O.

**C.S. MEAL
MILL FEEDS**

Always get our prices before buying elsewhere. Mixed cars a specialty. The D. B. Co., Blanchester, Ohio.

Bacteria of Uncleanliness

Bacteria of uncleanliness are real factors to be considered in every problem of sanitation.

You either feed them, permitting multiplication in almost incredible numbers, or you literally starve them out. Obviously you prefer the latter, and what is equally apparent,

Indian in Circle



In every package

Wyandotte
Dairyman's
Cleaner and Cleanser

comes nearer putting bacteria on the starvation basis than any other known washing material, as its use abundantly proves.

It does it because it possesses greater washing power, because it does not attack the surface washed, because it rinses easily and because it contains no organic matter.

It was made purposely to cope with the conditions of uncleanliness, and it does it. Not only does it clean everything, but it cleans everything **clean**, since nothing short of such a condition would satisfy. And its cost is no more than that asked for just ordinary washing materials. Ask your dealer, or if you wish further information, write us.

The J. B. Ford Co., Sole Mfrs., Wyandotte, Mich.

This Cleaner has been awarded the highest prize wherever exhibited.

IT CLEANS CLEAN

WHY CO-OPERATION PAYS MOST MONEY FOR CREAM

Because we pay the freight and pay the "Tenths." See the value of the "Tenths" to **Wm. G. Fields, Loveland, O.**, who shipped us during September, 1916, as follows:

WITH THE "TENTHS" COUNTED				WITHOUT THE "TENTHS" COUNTED			
	Cream	Test	Fat		Cream	Test	Fat
Sept. 2.....	39.0	36.2	14.11	Sept. 2.....	39	36	14.04
Sept. 7.....	39.5	34.2	13.50	Sept. 7.....	39	34	13.26
Sept. 9.....	38.8	35.8	13.89	Sept. 9.....	38	35	13.30
Sept. 14.....	38.7	32.8	12.69	Sept. 14.....	38	32	12.16
Sept. 19.....	39.5	33.8	13.35	Sept. 19.....	39	33	12.87
Sept. 23.....	39.7	34.2	13.57	Sept. 23.....	39	34	13.26
Sept. 30.....	39.5	31.8	12.56	Sept. 30.....	39	31	12.09
			93.67				90.98

Mr. Field's "Tenths" gained him 2.69 pounds of fat worth \$0.86.

We paid "Freight" back to him on 7 cans of 15c each equal to 1.05 cents.

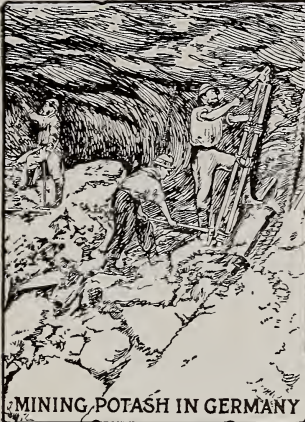
We sent him a check for \$31.17. \$31.17 divided by 90.98 equals 34.2. At "Elgin" average price his "Tenths" and "Freight" paid him 34.2 minus 32.1 equals 2.1 cents above "Elgin."

This is why you get more money from

The West Jefferson Creamery Company

Columbus, Ohio—Zanesville, Ohio.

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MINING POTASH IN GERMANY

Do Fertilizers Pay?

The Government and Educational "Authorities" spend considerable public money in printing contradictory statements on this point.

Great fortunes have been made in manufacturing fertilizers. They evidently pay the makers.

Farmers continue to increase their fertilizer purchases, indicating that they are profitable to the farmer.

But are the kinds which the manufacturers prefer to sell the most profitable to the farmer? Do they give the greatest profit consistent with maintaining the productiveness of the soil? Or do they merely supply the element most needed at the moment and reduce the available supply of the other elements?

The average fertilizer contains 4 times as much phosphoric acid as Potash. The average crop takes from the soil 3 times as much Potash as phosphoric acid. You can guess the answer. Use more Potash, for

Potash Pays

Send for FREE pamphlet on Profitable Farming, containing system of rational fertilizing and soil testing.

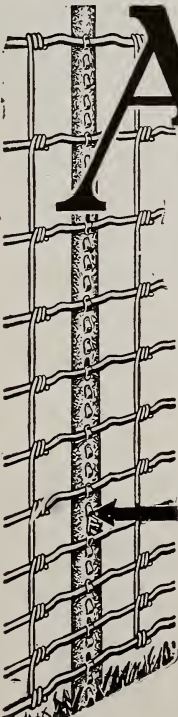
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McCormick Block, Chicago, Ill.

25 California St., San Francisco, Cal.

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American Fence

Big, full gauge wires — full weight — full length rolls woven with a mechanically hinged joint. Superior quality galvanizing — proof against hot sun, sleet and snow.

Awarded Grand Prize at Panama-Pacific International Exposition—the supreme award of merit.

American Steel Fence Posts last a lifetime. Hold fence secure against all conditions.

Sent Free

Write for booklet on how to set posts and erect fence. Every farmer should have it.

DEALERS EVERYWHERE

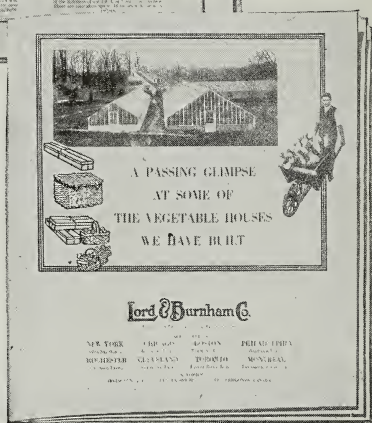
AMERICAN STEEL & WIRE CO.

Chicago—New York—Pittsburgh—Cleveland—Denver

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This Circular Gives a New Angle On Making the Farm Pay



IT tells how the farm can be made to pay a good snug profit every month in the year—not just half of them.

It cuts right to the core of the intensive farming question by not only telling what can be done under glass, but by telling what actually has been done.

It gives you an idea of what you can do by telling you what the other fellow has done.

It shows Lord & Burnham greenhouses that are now being used by the

prominent growers all over the country. Also some who are netting good substantial profits as well as those who are just starting in with greenhouses on a small scale. Gives facts and figures about each. States some good hard-headed common-sense about the differences in greenhouses and why it costs less in the end, to buy the Lord & Burnham kind at the start.

It's a veritable guide-post to intensive farming with its all-year-round profits. Send for it.

Lord & Burnham Co.

Builders of Greenhouses and Conservatories,
SALES OFFICES

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BOSTON,
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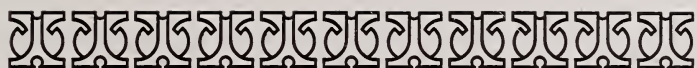
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FOR the REASONS why
Ohio people carry *more*
insurance in The Northwestern
Mutual Life than in any other
company (Industrials excluded)
communicate with

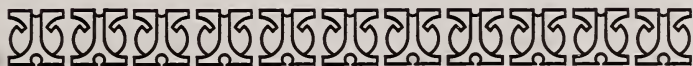
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Cream Separators

SAVE IN SEVEN WAYS

QUANTITY of cream that no other separator will recover completely, particularly under the harder conditions of every-day use.

QUALITY of cream as evidenced by De Laval butter always scoring highest in every important contest.

LABOR in every way over any gravity system, and also over any other separator, by turning easier, being simpler, easier to clean and requiring no adjustment.

TIME by hours over any gravity system, and as well over any other separator by reason of greater capacity and the same reasons that save labor.



COST since while a De Laval cream separator may cost a little more than a poor one to begin with it will last from ten to twenty years, while other separators wear out and require to be replaced in from one to five years.

PROFIT in more and better cream, with less labor and effort, every time milk is put through the machine, twice a day, or 730 times a year for every year the separator lasts.

SATISFACTION which is no small consideration, and can only come from knowing you have the best separator, and being sure you are at all times accomplishing the best possible results.

The De Laval Separator Company

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